The Dock & Harbour Authority

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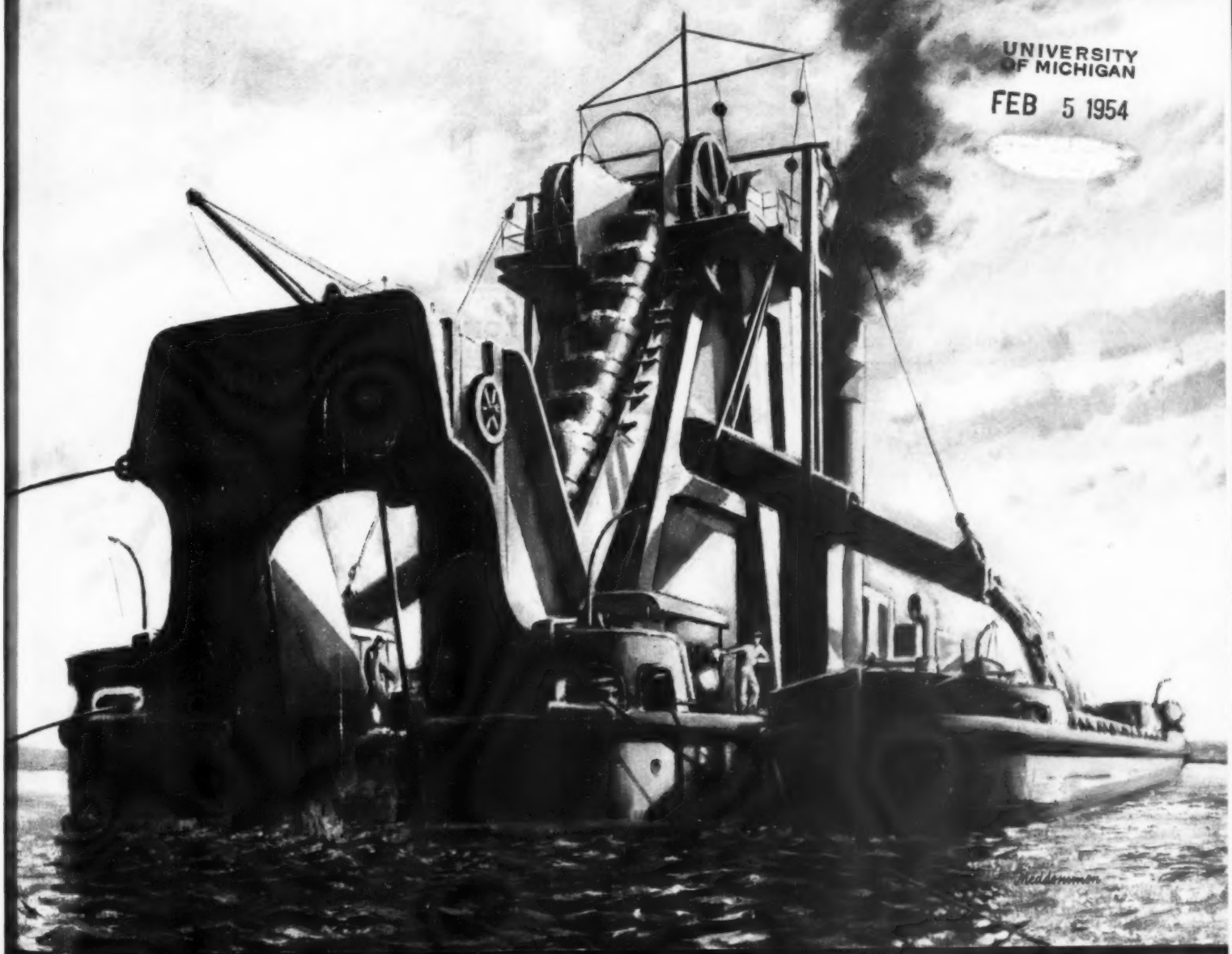

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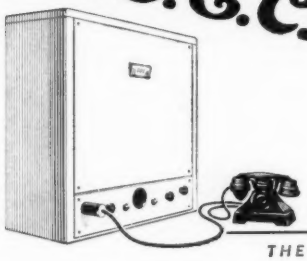

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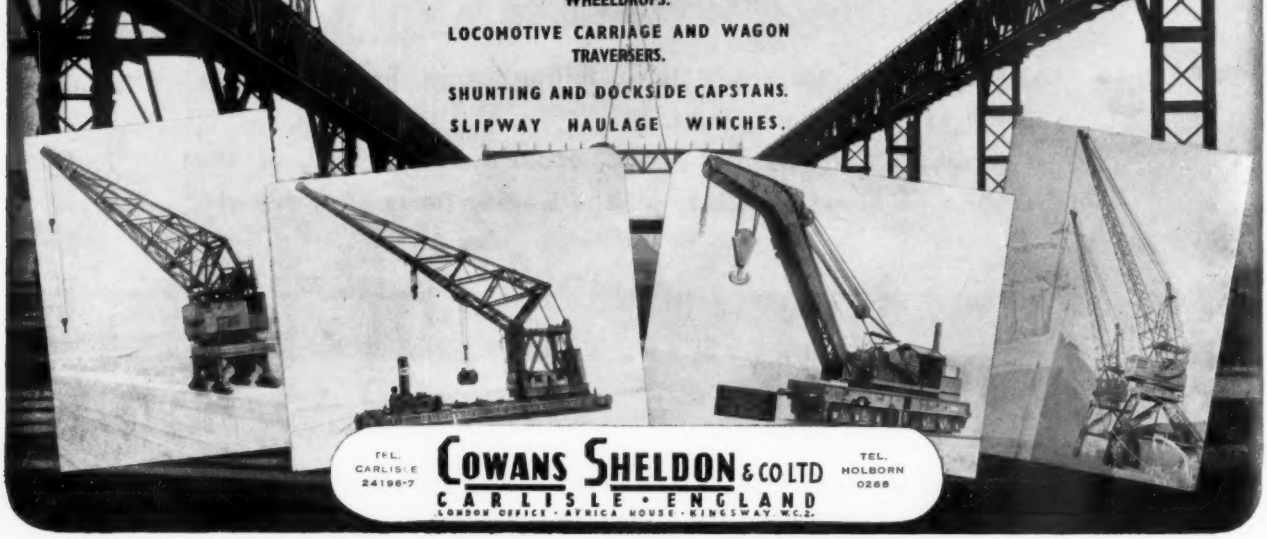

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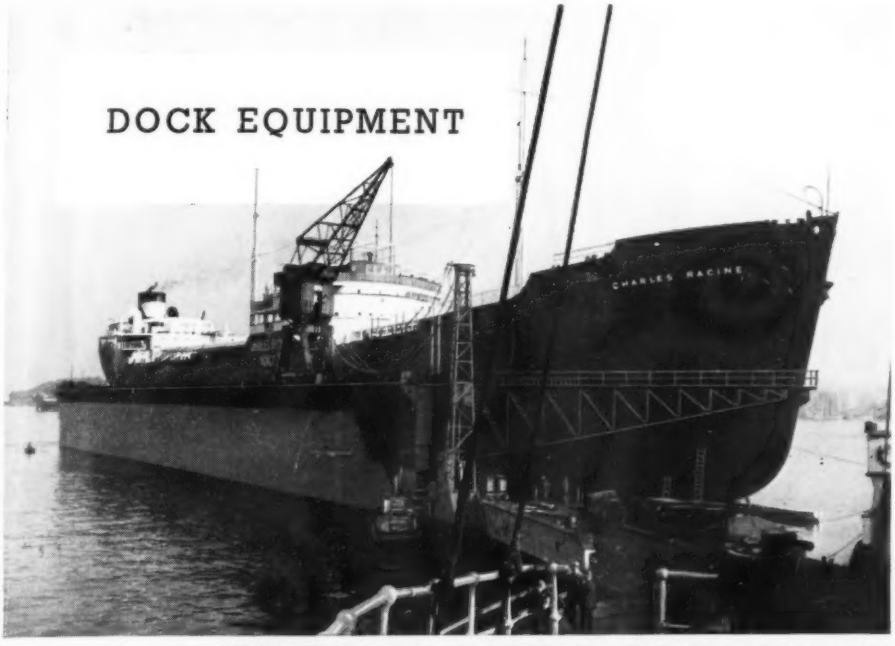

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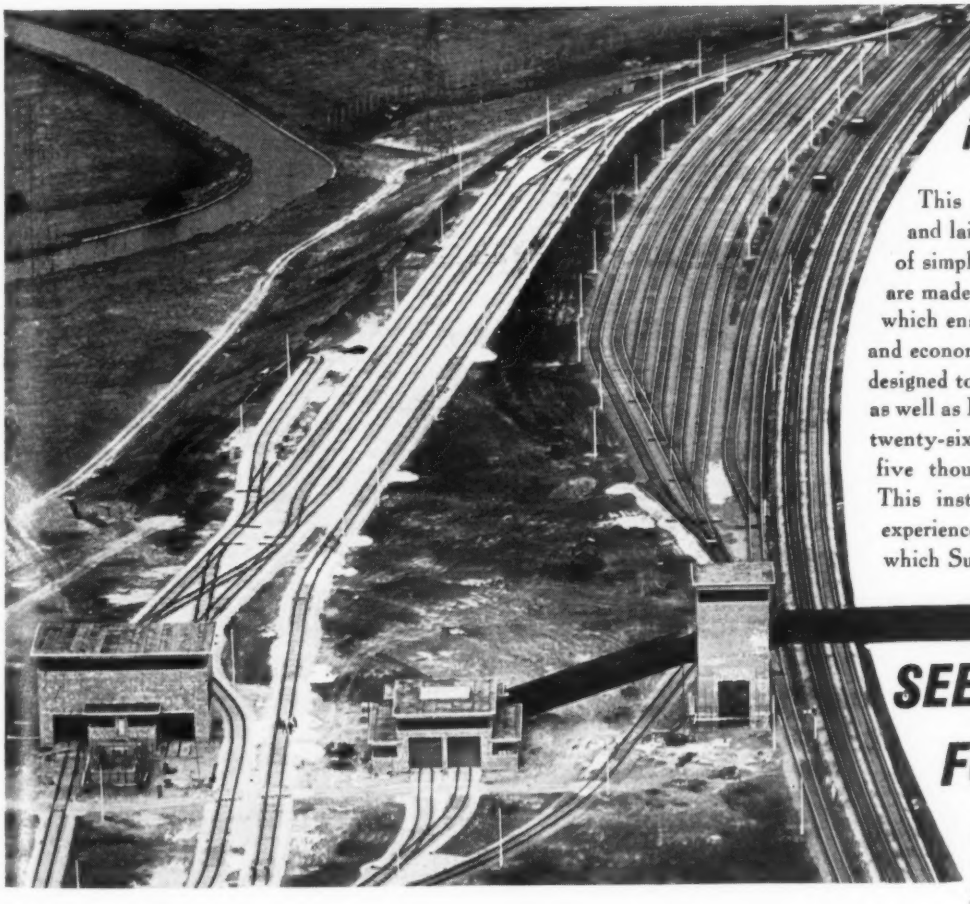

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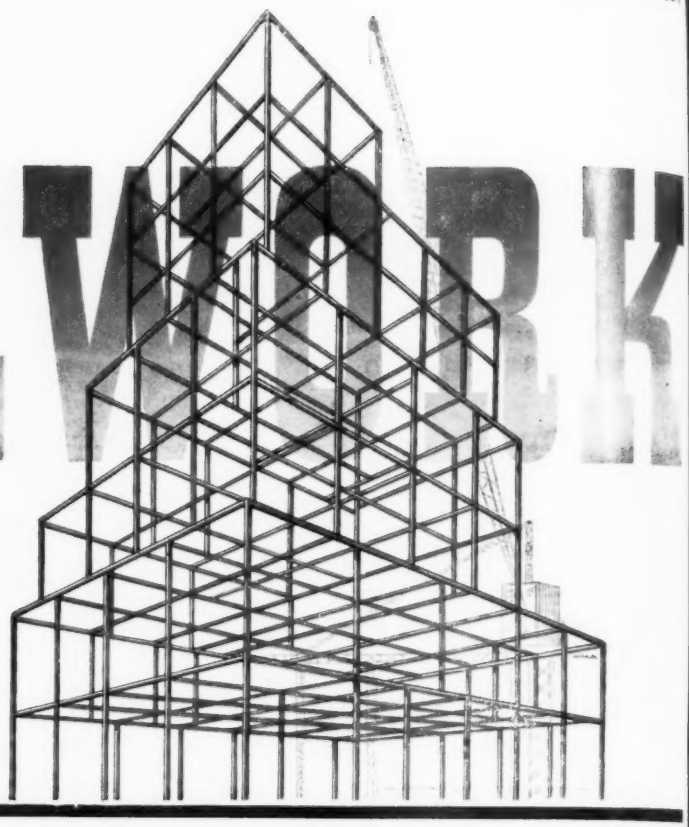

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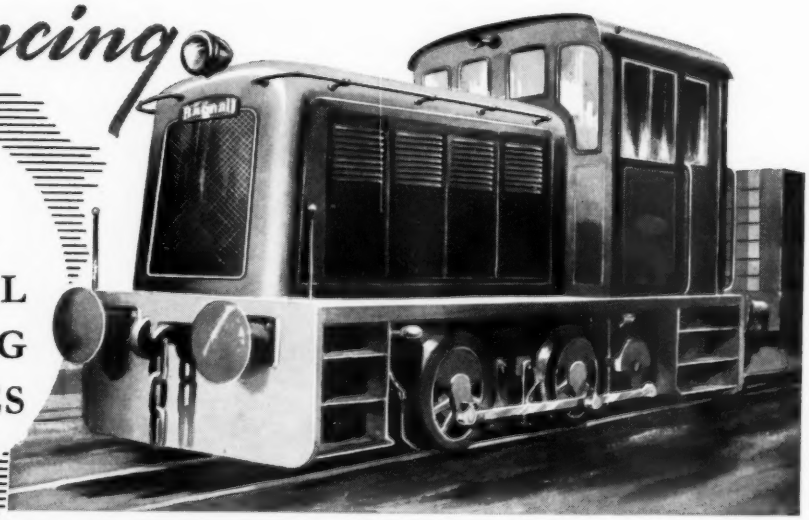

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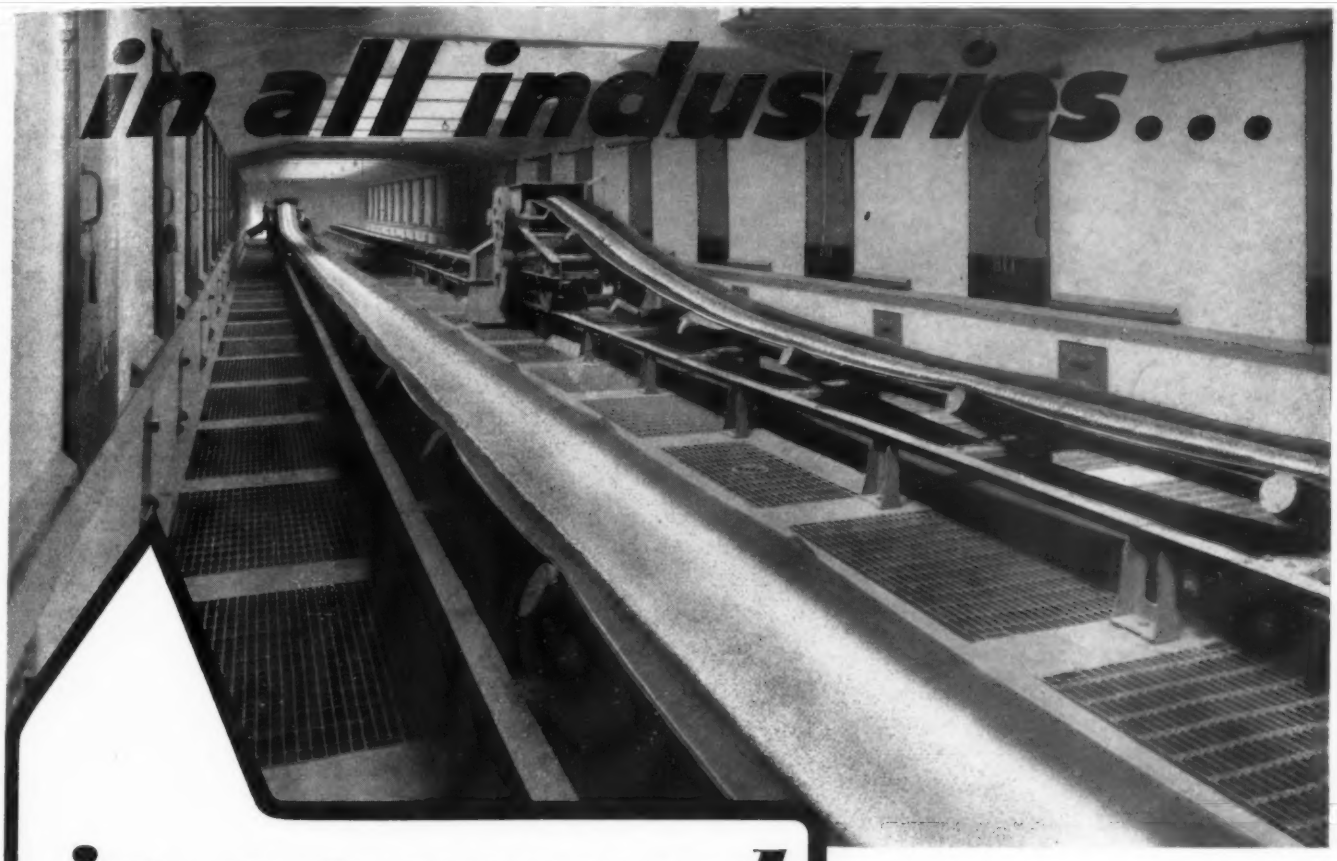

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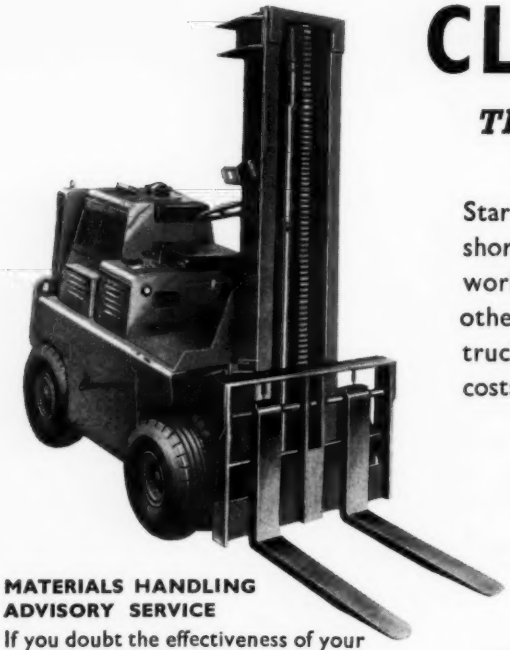

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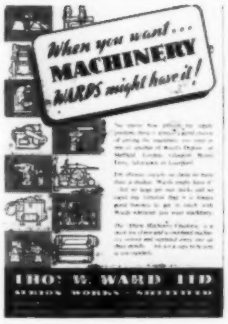

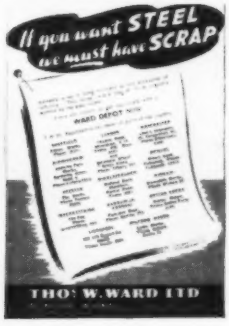

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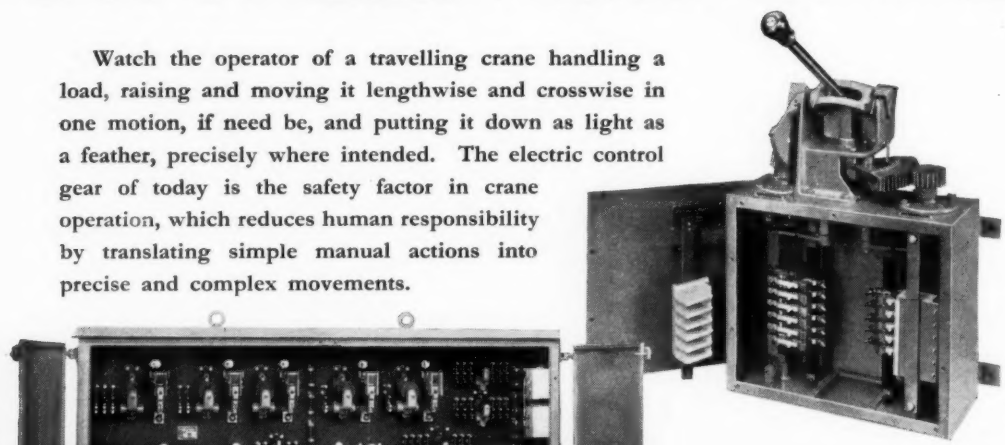

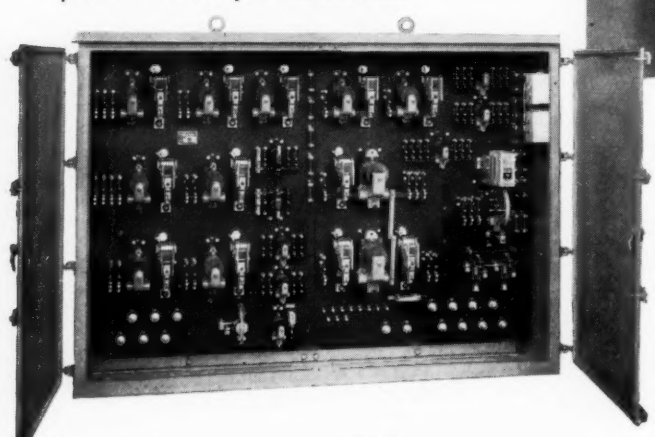

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The Dock & Harbour Authority

An International Journal with a circulation extending to 72 Maritime Countries

No. 399

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JANUARY, 1954

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Editorial Comments

The Port of Antwerp.

In our last issue, the leading article dealt with the Port of Amsterdam, and in previous numbers, details were given of the Ports of Rotterdam and Ghent. We are fortunate in now being able to give our readers an account of the Port of Antwerp, thus completing our review of the four major ports which form the chief gateways to Europe through an elaborate system of inland waterways.

During the Second World War, Antwerp was fortunate in being retaken by the Allied forces before the retreating German army had been able to give effect to their " scorched earth " policy. At the same time, however, widespread devastation was inflicted upon the city and port by heavy flying-bomb attacks towards the end of the war, so that considerable reconstruction works had to be undertaken.

The problem that the port authorities had to face after the cessation of hostilities, however, was principally the obsolescence of the port's equipment and quayside facilities. The outmoded layout of sheds, roads and railways also created difficulties in meeting the post-war increases in trade.

While much has been accomplished to remedy this position, the port has become too small to cope with its post-war shipping boom. Owing to its strategic position in the Scheldt, more than 230 shipping lines now use the port to trade with every part of the world. Now, inundated with enquiries from new lines seeking similar facilities, the City Council is in the invidious position of having to refuse trade which it would otherwise be only too glad to accept.

In 1952, a total of 11,756 seagoing ships representing 28,027,193 tons, entered and cleared the port—the highest tonnage ever recorded, and the latest statistics show that 1953 will see another record.

To remedy the lack of berths, a large basin is being constructed at a cost of more than £4 million. Although this will take some two years to build, practically every berth in the new basin has already been reserved, and the port's accommodation problem will be little nearer complete solution even when the new dock is finished. Consequently, work is expected to begin on another basin as soon as the first has been completed.

To serve these new and projected basins and to provide better entrance facilities to the port as a whole, a new lock—the Baudouin —is being constructed with Government aid. It is expected that this will be completed at the same time as the first of the new basins.

The present general management of the Port of Antwerp is in the hands of the City Council, with day to day administration controlled by a Port Committee formed by the Burgomaster and Aldermen. Questions of policy, and other matters, are examined by a Commerce and Navigation Board, which is assisted by the general manager of the Port Administration, who assumes control of the various port departments, both administrative and technical.

It is reported, however, that a new organisation called the Antwerp Port Community, is now to be constituted to collaborate and advise the City Council upon all port matters. Shipping, commerce and stevedoring will be represented on the board of directors in equal numbers, and the Port Community will also study the rationalisation of labour in the port area, the establishment of courses of training, propaganda, etc.

Some such organisation already exists in the Centrale des Employeurs du Port d'Anvers which acts as the liaison between Antwerp shipping interests and dock labour.

The general situation in the port in respect of its administration and the present proposals, is of considerable interest, and it will be instructive to watch the outcome of these plans to stimulate technical and commercial efficiency.

Tonnage Measurement of Ships.

Controversy concerning the methods of measuring the internal capacity of a ship to compute the net register tonnage has been a matter of some importance ever since steamships started competing seriously with sailing vessels. The old method of obtaining the tons " berthen " by multiplying the dimensions of a ship, and then dividing by the sum of the quotients, made no allowance for the so-called non-earning parts of a ship. These complications were introduced later by the " Moorsom " Tonnage Rules, so named after the secretary of a committee which in 1852, devised a new system of tonnage measurement. This came into force a hundred years ago in the Merchant Shipping Act of 1854. Under these rules, which have been amended from time to time, certain internal spaces of a ship are not included in the gross tonnage. Further, large deductions are made from the gross tonnage to compute the net register tonnage on which dock and harbour dues are assessed. What should be, and what should not be deducted, has frequently led to controversy between shipowners and dock owners.

When the Board of Trade appointed, in 1905, a committee to enquire into the differences of the Cunard Steamship Company and the Mersey Docks and Harbour Board, with reference to the net register tonnage of some new Cunard passenger liners, the committee could not agree among themselves. There was one interesting outcome however—a recommendation of the minority members was embodied in the Merchant Shipping Act in 1907.

After the first world war, the League of Nations set up a technical committee on maritime tonnage measurement but were unable to recommend any improvement in the British Tonnage Rules, or persuade other maritime nations to adopt them completely. In 1951 the United Nations Transport and Communications Commission agreed that the Inter-Governmental Maritime Consultative Organisation should deal with the unification of maritime tonnage measurement. It remains to be seen whether they will meet with any more success than the technical committee of the League of Nations.

Editorial Comments—continued

It seems certain that any alterations to the tonnage measurement system will be modifications of the existing British method, in spite of the suggestions made from time to time of a complete breakaway. Under the present system, which was referred to in these columns in our issue of June 1953, cases of unequal treatment with reference to dock dues based on net register tonnage, as between ship and ship, are bound to occur. As much as port authorities would like to put this right, they can do nothing while the Merchant Shipping Act of 1894 governs the method of computing tonnage. On the other hand any change may create such opposition by payers of dues—who may consider that they might be worse off under a new system than the old—that the success of any modifications seems doubtful. The difficulty is to create a new system that would be acceptable to all.

Elsewhere in this issue, a contributor has put the case in the form of a survey of this controversy, and has included a possible solution for the simplification of the present methods.

The Hawkesbury River Bridge.

On a following page will be found the first instalment of an article describing the construction of the new highway bridge in New South Wales.

While this bridge is not directly connected with dock and harbour work, nevertheless, the design and construction of the river piers have features of maritime engineering which are of particular interest. We refer to the caisson which formed the pier between the two main bridge spans, the sinking operations of which, through a great distance, was satisfactorily accomplished with remarkably small lateral deviations.

This work is described in the present issue, while a diving-bell method of construction of the piers on permanent piles and other interesting features will be dealt with next month.

The bridge was designed by the Australian Government Department of Main Roads, and its construction entailed a great variety of problems, representing a successful co-operative effort under difficult war-time conditions. The fact that there were no serious accidents is a tribute to the meticulous care taken, in all details, by the supervising engineers and contractors engaged on the work.

Proposed Increase in Canal and Dock Charges.

The increase in wages to British railway staff, which has recently been announced, has been added to an accumulation of other increases in costs of railway operation which had already reached threatening proportions. This has been sufficient to force the British Transport Commission to apply for a further ten per cent. increase in railway freight charges and dock and canal charges.

This follows increases in 1951 and 1952, which it had been hoped would be sufficient to stabilise the budget. The latest proposed increase should swell revenue by about £25 million per year, but all the recent increases in costs, including those arising from improved maintenance and displacement of obsolete plant, will amount to about £15 million per year. In addition, the Commission is losing the profits of the Road Haulage Executive, which at £7 million per year have represented more than a proportionate contribution to the Commission's interest and central amortisation charges.

Although it seems inevitable to increase railway freight charges on account of the new railway wages award, we are not altogether happy that it is proper or advisable automatically to increase charges for the use of the Commission's Docks and Canals by a like amount. Perhaps, in the case of the Canals, the intention is simply to increase charges on existing traffic to the maximum extent that the traffic will bear; canal freight rates are inevitably controlled by the competitive railway charges. This policy is hardly likely to attract traffic to the canals, in face of intensified road competition. At a time when public interest in the greater use of Inland Waterways has been aroused by various pronouncements in the National and London Press these new increases seem regrettable.

This interest in the possible greater use of the canals has been heightened by resentment at the destruction of a road bridge by a heavy road vehicle transporting an exceptional load. It has been suggested that this type of load would be more suitable for carriage by canal. Unfortunately, however, upon too much of the English canal system, loading is restricted by small gauge and limited draught and headroom. If the canals are to make a considerably increased contribution to our transport facilities, and reduce the appalling toll of road accidents, the Commission must be allowed to embark upon a programme of modernisation and enlargement, aimed at accommodating estuarial barges over the major routes.

Many proposals to this end have been presented in this Journal and elsewhere, and the problems of English canals authoritatively analysed. If the suggestion of a " renewed and vigorous drive for increased efficiency " by the British Transport Commission is seriously advanced, the canals must not be neglected. Without modernisation, we doubt whether the Inland Waterways can economically carry much more than their present proportion of the total traffic.

Further Threat to Canal Traffic.

Amongst the difficulties with which the English canal industry is beset to retain existing traffic, is the gradual exhaustion of coal and other mines and quarries along the banks of the canals. In many cases, canals were originally aligned to serve such mines, and while they continue in operation, the canals are favourably placed to compete with other forms of transport.

At a public enquiry opened in Nuneaton this month, in response to an application from the National Coal Board for permission to mine under Arbury Hall, a house of national importance and of special architectural and historic interest, the Coal Board revealed that, without this permission, mining at Griff pit would be seriously restricted. Since a substantial part of the canal-borne coal traffic to the London area has originated at Griff pits, this may prove to be another threat to canal tonnage. We can only reiterate that to maintain canal traffic, the Transport Commission must adopt a forward-looking policy aimed at attracting new traffic. To prosecute this policy with any hope of competing successfully in the long run, drastic changes are necessary. These changes must include, firstly, enlargement on certain major routes, and secondly, an end to the present state of affairs, under which the Commission's limited resources are spread too thinly over an extensive canal network, including too much mileage with little traffic potential.

Ship types and future tendencies.

This is a subject which always evokes interest. On page 270 of this issue is a synopsis of a lecture on " Merchant Ship Types and the Future Tendencies" delivered by Mr. A. C. Hardy, B.Sc., M.I.N.A.

As will be seen from the sections quoted, Mr. Hardy's approach was a broad one and the developments and tendencies he mentioned covered a wide range. In this sphere, however, it may be useful to make a sharp distinction between the respective implications of " developments " and " tendencies" ! The use of sea-trains, for example, and " a complete harbour with sheds, barges, etc., which can be carried in the hold of a large ship with machinery aft, dropped over the side and assembled in place " are certainly developments; but, considering cargo vessels as a whole, they may not reveal tendencies.

In lake and short-sea trading there may be an increasing tendency to adapt the ship to the traffic, also in cross-ocean trading, special ships are becoming even more specialised, but it is debatable whether the **proportion** of specialised ships is appreciably increasing.

As far as Great Britain is concerned, import and export cargoes are so miscellaneous that it is not primarily the type of cargo which controls ship design; it is any factor which makes for the fullest use of the maximum space and for quick discharge and loading.

If and when large quantities of palletised cargoes are carried in ocean-going ships—and there is no sign that such a development is imminent—this emphasis may be altered, for then the type of package carried, viz. the unit load, will itself be a factor in quick turn-round.

To Great Britain, then, it is probable that the most important tendencies are those concerned with the evolution of the general cargo vessel.

The Port of Antwerp

Noteworthy Post-War Expansion

(Specially Contributed)

MR. OSCAR LEEMANS, the General Manager of the Port of Antwerp when asked to what he attributed the thriving condition of the port prefaced his reply in the following strain. In the first place it must be appreciated that a commercial port is, in a manner of speaking, a most complex organism and to gain a just perspective it is essential to define the constitution of its parts and their functions. Actually wherever the activity of human beings takes place in the pursuit of livelihood there is a close relationship between the tools of the trade, craft or occupation and the persons using them—there is an element of reciprocity between the two, explain it as you will. Thus the port itself comprises a complexity of movement and action, dominated by many external influences which, each and all, affect to some extent the port functions and, as a consequence, continuing the simile of an organism, condition its organs; on the structural side, docks, lock chambers, sheds, warehouses, dry docks, quays etc.; the circulating system, navigable channels, roadways, bridges, railways and rolling stock; and for motor all the mechanical equipment.

Constitution of Antwerp Port

The seaport history of Antwerp goes back to the Middle Ages but sufficient for our purpose commences in 1805 when 2,400 ships entered the harbour. After the battle of Waterloo the Belgian and Dutch provinces were united but in 1830 revolution broke out and Belgium became independent. Freedom of navigation from Antwerp to the sea through the Schelde estuary proclaimed by the Vienna Congress in 1815 was again threatened; the Dutch wished to close free access. The great Powers of the time did not agree, particularly Great Britain who insisted on entire freedom. Nevertheless the way to the Rhine was blocked by Holland. To compensate for this loss Belgium constructed a railway to Cologne which was opened in 1843. This speedy communication soon placed Antwerp as the first port in German export trade.

In 1863 with the financial aid of England and other countries the Belgian Government redeemed the crushing toll which Holland was allowed to levy on the Scheldt traffic. This freedom and the entry of steam propelled vessels and industrialisation opened up a new era of port development. Henceforward Antwerp grew steadily in maritime importance and in 1913 the goods traffic attained 18,872,000 tons when the water surface area of the docks was 240 acres only. In 1926 the port welcomed its 10,000th ship for the twelve months and a goods traffic of 26 million tons. In 1937 the traffic rose to 28,367,000 tons. The following figures of post-war traffic need no comment.

GOODS (SEABORNE) IN 1,000 TONS

Year	Inward	Outward	Total	Year	Inward	Outward	Total
1947	16,004	6,253	22,257	1950	10,661	10,846	21,507
1948	13,810	7,261	21,071	1951	15,280	14,080	29,360
1949	11,382	8,576	19,958	1952	15,651	11,831	27,482

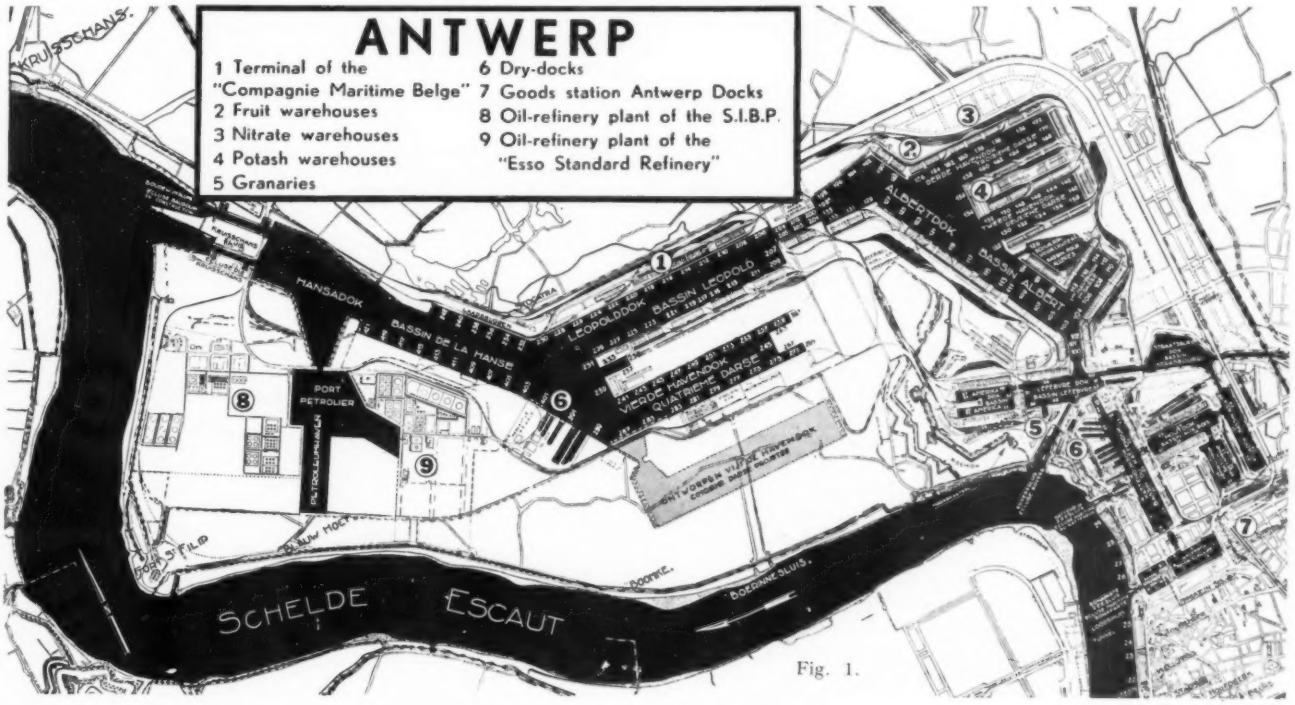


Fig. 1.

Area of marine docks (water surface)	...	1,150 acres
Area of inland traffic docks	...	87 acres
Length of quays for vessels	...	40 kms.
Length of wharfage for lighters	...	6.5 kms.
Total area of quay sheds	...	175.0 acres
Total area of warehouses on quays	...	17.5 acres
Total area of grain storage silos	...	12,000 sq. m.
Total area of potash storage	...	18,000 sq. m.
Total area of cold storage	...	16,000 sq. m.
Total area of public stockage	...	21 acres
Total area of oil installation stockage	...	1,300 acres

With storage tank capacity of	...	1,150,000 cu. m.
Length of railways and sidings	...	500 miles
Publicly-owned cranes	...	560
Privately-owned cranes	...	150
Floating cranes (3.5 T—5 T) (10 T—150 T)		20
Floating grain elevators	...	21
Towing craft (of which 12 are diesel of 5 to 7 tons pull)	...	36
Dry docks publicly owned	...	10
Dry docks privately owned	...	5
Entrance locks to river Schelde	...	4

The Port of Antwerp—continued

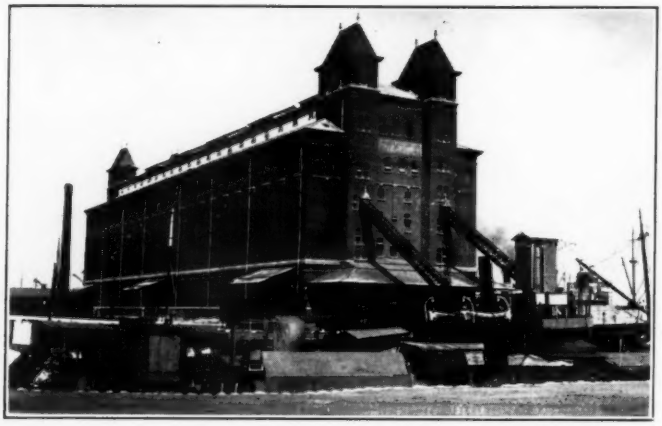


Fig. 2. Grain silos in Lefebvre docks.

Antwerp is situated about 88 kilometres from the North Sea on the right bank of the river Scheldt (Escaut) a tidal river which fortunately for Antwerp tends to maintain the depth of water necessary for the navigation of modern liners. It has a river quay frontage of 5.5 kms. in deep water equipped with sheds, cranes and rail in the old town, and has extended considerably to the north of the city. (See details at foot of Fig. 1.)

Entrance Locks

The Buonaparte lock 17.50 m. wide and 2.65 m. water depth at M.L.W. and the Kattendijk lock 24.80 m. wide and water depth of 3.20 m. at M.L.W. are those solely for service of the inland waterway traffic. They lead to the older docks nearest to the heart of the city and were built in 1811 and 1860 respectively.

The Royers entrance lock in the first sharp bend of the Scheldt just north of the city has a length of 180 m. (594-ft.), a width of 20.0 m. (65-f.) and 6.60 m. (21.75-ft.) water depth at M.L.W. and gives access to the Lefebvre dock and the Albert docks.

The Kruisschans lock (1928) is 270 m. (882-ft.) long, 35.0 m. (115-ft.) wide and has 10.00 m. (32.8-ft.) depth of water at M.L.W. It is situated in the sharp bend of the river 3 kms. above Kruisschans and 12 kms. below the Royers lock. It is the only usable lock for large sea-going vessels until such time as the companion lock Baudouin shall be completed. It is with these appointments that the port deals annually with 9,500 to 12,000 vessels of a nett tonnage of 19 to 24 millions. In 1937, records show that 12,386 vessels of a total tonnage of 25,120,000 tons used the port.

Post-war Difficulties

After the cessation of hostilities, unlike the other great West European seaports, Antwerp found herself in the fortunate position of still possessing for practical purposes a port with equipment almost intact. There were damages but not functionally serious, amounting to about £5,000,000 sterling which did not hinder the operational activity. It should be recorded that a large proportion of the damage occurred towards the closing stages of the fighting under the bombardment of the V bombs when the port was being used almost entirely for Allied military material. During this period, dockers, stevedores, shippers and crane drivers rendered excellent service. In common with all ports on the North Sea coast the best and most modern of all equipment, quayside and floating cranes, locomotives, dredgers and tugs were commandeered by the Germans.

However out of the losses there were compensations and the port immediately gathered momentum with the influx of Allied goods, the while hurrying forward with terrific energy the reconstruction of sheds and other structures for which material was available. Nevertheless the Authority was concerned about the future. There was a feeling that their old-time competitors although more seriously handicapped by enormous destruction would push forward the rehabilitations with new and up-to-date equipment and layouts, thereby on a long-term basis overcoming the temporary handicap. Whereas Antwerp, they thought, in spite of getting off to a quick start was saddled with inadequate and worn out equipment only and, further more, would not be able to have the modern layout of sheds and quayside that the others would be forced to construct. This was a cause of much anxiety and discussion, particularly in view of the fact that the war expedients had evolved new methods and designs of maritime activity in form, dimension and tempo.

Not least of the changes in the last decade during the occupation years was in the increased average size of vessels, a factor which had a direct bearing on the possibilities of the existing quayside equipment (as noted above the older type predominated) being sufficiently adequate to deal with them as efficiently as in the pre-war set-up. The increased capacity of the vessels and the enormous capital invested in them demands ; (1) the need of greater areas for storing and stacking in the quayside sheds, (2) the need of more handling equipment, i.e. lifting cranes, or the necessity of utilizing the installations to a greater extent with the aim of maintaining or bettering the tonnage rate of discharge or loading, thus ensuring the rapid turns of vessels at the same quays, a condition that every day shows to be imperative. It is only by such measures that the turn-round in port can be rendered more speedy and economical. Arising from these considerations it is logical that reconstruction of war damage in site, dimension, power and layout should only comprise that of the original which can be easily re-adapted to modern conditions.

Again there arises another important point: for it is not only the evolution of marine transport which forces in ports the re-adaptation, or re-modelling, of the quayside installations. From the landside itself the demands of accommodation and conformity are just as important on the circumstances of the reception, despatch and distribution of the goods. It is the crystallization of an economic force pushing in the same progressive way as the larger sea-going unit. Before the war road transport in the handling of cargo had only a third rate use in Antwerp as a vehicle of inter shed distribution much as a trolley on a railway station platform, it was not a unit that had to be considered as an important part of the port's main installations. After the war this situation was profoundly modified to such an extent that it is now a serious problem in all old ports.

For the future it is incumbent on all port authorities to provide the means to conduct large lorries right to the centre of all installations, that is to say, on the quay alongside the vessel, and to the sheds or even into the sheds. Such provision will directly influence the layout of the quay apron and the methods of working to avoid interference between rail and road vehicles. This will call for access roads, turning spaces, and pavements to top of rail level, all of which in turn requires wider quay aprons and maybe in many cases more substantial design. Besides these immediate port needs there arises a wider implication in as much

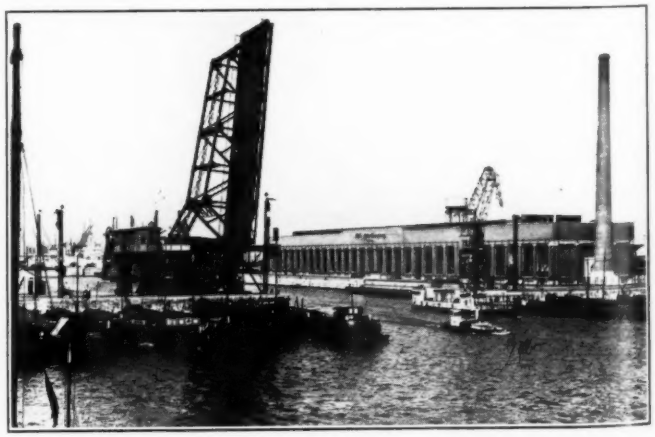


Fig. 3. Automobile assembly shop and bascule bridge at east end of narrow channel between Leopold and Albert Docks.

The Port of Antwerp – continued

since the road transport systems have assumed an importance equal to that of rail, or waterways, the attention of the Port Authority must of necessity be interested, or directed, in the navigation or the land channels, in the form of approach roads to and from the port. There will have to be some sort of collaboration, or co-operation, between the Road Authorities and the port to avoid bottlenecks and long period obstructions. Within the vicinity of the port boundaries the roads will have to be laid out to prevent traffic jams by the provision of one-way circulating systems with clear location and direction boards conspicuously placed. Another important point is that efficient control must be exercised on incoming road traffic to avoid the congregation of too many lorries and trailers waiting on the quayside.

Modern Installations

It is evident that the present tendency of the increasing use of road transport must affect in an ever greater degree the capacity of a port to collect and distribute by road exports and imports with an efficiency at least equal to that attained at the quayside by rail and inland waterways.

Besides the evolution of the quayside appliances for general traffic, as much a consequence of the modifications on the marine side as on the land side, there are still other factors inherent in the nature of the methods of working on the quay which force more and more to a specilisation adapted to the traffic of the vessels berthed, and this leads to a further evolution in appliances. These factors are not new since the last war, in fact they can be traced as a consequence of the first world war.

There has always existed in Antwerp ship berths exclusively reserved for special traffic or with specialist equipment, but it should be understood that these were furnished entirely by administrative instructions as a contingency for unusual demands. A single exception existed before 1918, notably the concession of quays and deposit space accorded since 1892 to a private company for the erection and exploitation of grain storage in the Lefebvre dock (Fig. 2.) About 1928 when the world had settled down to peace time aspirations and had overcome the depression ensuing after the first world war one registers a more vigorous recrudescence of functional development manifested by the realisation, by private initiative, of installations more specialized, of which a number clearly were port industries. At that time there were granted a series of encroachment contracts on port property on a long-term basis which can be classified in three distinct groups.

(a) of private berths at the quayside with areas of storage and with mechanical equipment for the handling of particular goods such as the Solvay installation, cold storage, fruit storage.

(b) of installations directly concerned in the development and the stabilization of handling equipment of bulk cargoes, such as fertilizer storage (Fig. 5) and the necessary discharge conveyors.

Fig. 4. Cold stores. 2,400,000 cubic feet capacity—12°/—14° C of which 10,000 cu. ft. at —20°C.

Fig. 5. Potash storage in Albert dock.

(c) of installations on the quay apron or in close proximity with a characteristic industrial activity, such as timber sawmills, workshops to mount automobile parts (Fig. 3), mechanical appliances for the breaking and screening of anthracite, and oil refinery installations.

In the last few years the development of these interests has increased considerably, some, like cold storage (Fig. 4) have doubled capacity—for example the rapid growth of oil refineries has surpassed all pre-war expectations requiring much greater berthing space and large areas for tank storage. Again, new installations for tank storage of edible oils and molasses, cattle foods, fabricated and steel sections, and many other important industrial materials claimed attention.

In this connection it is worth while saying a few words on the handling of bulk cargoes and the character of the traffic handled at Antwerp. There appears to a widespread misapprehension regarding this. One sometimes hears that Antwerp is specifically a "general merchandise port." A few statistics of the actual traffic should dispel this limitation of the port's activity, in fact, it was never true.

COMPARISON OF BULK AND GENERAL CARGO

Year		Discharged in 1,000 tons	Loaded in 1,000 tons	per cent.	Total in 1,000 tons
Bulk Cargo					
1937	...	9,818	5,344	37.9	15,162
1938	...	7,927	5,155	44.0	13,082
1950	...	7,356	3,812	35.1	11,168
1951	...	11,396*	3,950	28.1	15,346
1952	...	12,368	3,925	33.2	16,293
General Cargo					
1937	...	4,456	8,750	62.1	13,206
1938	...	3,946	6,551	56.0	10,497
1950	...	3,305	7,024	64.9	10,339
1951	...	3,884	10,130	71.9	14,014
1952	...	3,283	7,906	66.8	11,189

*Opening of oil refineries.

It is obvious that on the whole the proportion of bulk to general cargo is fifty fifty.

Over the last few years of imports 70 per cent. have been bulk cargo and 30 per cent. only general cargo; and of export the proportion is sensibly reversed. Even in the statistics of 1880 one finds that the entering traffic of 2,750,000 tons comprised 1,250,000 tons of cereals and minerals, coal, oils and wood accounted for another 500,000 tons.

Another misunderstanding is that Antwerp is entirely dependent on rail transport for distribution of and collection of goods. That the rail system is of the first order few will question. It is linked up efficiently with all national railroads, with international main lines, and direct to the quayside berths. The fact of the matter is that the volume of water-way traffic into and out of the port is greater than the rail traffic and still increases year by year. It is the main channel for the carriage of bulk goods and adds greatly to the transhipment facilities of the port.

For this particular activity there are 21 floating pneumatic elevators for grain, each having a capacity of 150 to 200 tons per hour (Fig. 6). The equipment is specially designed to load lighters. There are also 260 silos of various sizes having a total

The Port of Antwerp—continued

capacity of 55,000 tons served by three pneumatic elevators on the quayside and a belt conveyor having a total capacity of 420 tons per hour.

British Share of Antwerp Traffic

An important economic factor for Great Britain, and for all maritime powers is undoubtedly the income of the overseas trade and traffic. In this the British merchant fleet takes a predominant part. Belgium is not a great sea-faring nation. It is essentially an industrial and commercial nation. As a consequence Antwerp is a port of foreign flags among which the Union Jack is always prominent, as the following shows.

	1952		1951		1950		1937	
	Number	BNT in 1,000 tons	Number	BNT in 1,000 tons	Number	BNT in 1,000 tons	Number	BNT in 1,000 tons
U.K.	2,654	6,289	2,943	6,122	2,387	5,499	3,323	6,057
Holland	2,410	4,215	2,027	3,978	2,010	3,730	1,675	1,639
Norway	1,071	3,436	1,053	2,935	869	2,513	842	1,638
Belgium	614	1,714	600	1,626	544	1,557	586	1,155
Germany	1,309	1,422	1,094	940	766	448	2,445	6,717

These figures show that the United Kingdom represents 23 per cent. of the ships' tonnage whereas the figure for Belgium is 6 per cent. only but for the goods traffic the figures are 20 per cent. and 11 per cent. respectively. It is undoubtedly a fact of some importance that British owned shipping has a permanent character in the port of Antwerp. The situation in this respect is as follows:

REGULAR SERVICE OF SHIPPING LINES UNDER BRITISH FLAG IN 1952

Commercial Routes	No. of lines	Voyages	T.M.N.
Great Britain and Ireland	12	1,270	726,499
Mediterranean and Black Sea	5	100	320,900
North America (Atlantic)	3	88	500,088
South America (Atlantic)	3	50	253,246
Africa	5	102	556,971
Red Sea, Persian Gulf, India, Pakistan, Burma	7	220	1,237,729
Far East	2	51	303,256
Oceania	1	58	362,351
Totals	38	1,939	4,261,040

It is obvious from these figures that there must be a strong economic attraction to the Port of Antwerp which perhaps is partly explained by the extent of inland international traffic into and through Antwerp — which has served the heavy industries of France, Germany and Switzerland for many generations. In pre-war days annual traffic with Germany and France represented 5.0 and 1.5 million tons respectively and since 1950 2.6 and 3.1 million tons respectively.

Minerals and Coal

Owing to a number of unfavourable circumstances difficult to disentangle there was some measure of diffidence to equip the port during the 1920's with efficient mechanical appliances to handle coal and minerals in bulk. This tardiness resulted in considerable loss of traffic. However in 1931 two transporters of 15 tons capacity each, were installed on a quay length of 150 metres only with a storage area of 4,200 square metres. This departure proved of immense value and commenced a period of rapidly increasing tonnage handled. At the present time the quay length in service is no less than 750 m. with a storage area of 40,000 sq. m., served by 6 transporters each of 15 tons capacity (Fig. 7), 2 portal cranes each of 8 tons and 3 tracked bunkers each of 200 tons capacity for the loading of rail wagons. In contrast to 350,000 tons handled during the second half of year 1931 in the years 1937-8-9, 3,500,000 tons were handled annually. Following the last war, in the three years 1947-8-9 the traffic reached 4,000,000 tons and then owing to complex world causes there was a recession in 1950 but happily in 1951 trade again returned brisker than ever reaching the 5,000,000 ton mark. Even this was exceeded in 1952 so markedly that technical considerations were put in hand for extension of all facilities.

Fig. 6. Unloading grain by six floating elevators into large lighters at mooring buoys.

Emancipation of the Industrial Function

There is little doubt that the growth of the regional use of a port, as a distributing centre of a highly industrialised national inland territory and beyond the frontiers, in foreign lands, brings about other problems than the speedy interchange of goods to and from this hinterland. If, in effect, the national hinterland is a customer of steady volume, within agreed limits of variation normally favourable, it is not quite the same when dealing with the foreign areas beyond, of which the clientele may be many manufacturers who very often have little regard for the economy of transport or of the cost of the handling in the port itself, but who are in a large measure influenced by considerations of a political nature which manifests itself in measures of protection, or even favouritism, or perhaps euphemistically, discrimination. The evolution of traffic in West European ports, after the liberation of 1944 for example, has amply demonstrated that the more fortunate position was that for which the volume of traffic to and from the hinterland that it was necessary to share with competitors had the least relative importance. It is one of the causes explaining the remarkable resumption, after the war, of the traffic of Antwerp compared to that of its competitors.

In other words there is a major interest for a port to increase the durable part of its traffic, that lasting part constituted partly by national trade and partly, in a form more acceptable still, by the traffic which assures to the port its own industrial activity. In view of this it is not astonishing that ports encourage manufacturing interests which will help to stabilize traffic by establishing their works or depots within the port zone itself or in close proximity to their boundaries. Although all or any industries are acceptable, those which are directly interested in marine transport for the raw materials of their industry and/or the despatch of their products are particularly welcomed.

Such industries have existed in Antwerp for many years, they are for example, those for the transformation of exotic products, and in the period between the two world wars the works for the assembly of automobiles. Perhaps the most attractive industry to port authorities today is that of oil refineries, for although in themselves the undertakings represent an enormous capital and recurring traffic they also attract many other dependent industries of a highly modern character. Thus it was with great satisfaction that Antwerp was latterly able to facilitate the installation within her port zone of two powerful oil industries.

In this connection it is worthy to recall that Antwerp can claim direct industrial association with the beginnings of the oil industry in the world markets, in which it has played a part of importance since 1862. In those early days of mid last century and until

The Port of Antwerp—continued

Fig. 7. Transporter cranes for minerals and coal. Six of 15 tons capacity and two portal cranes of 8 tons capacity. 4-5 million tons handled annually from 600 vessels. 4,000 lighters and 100,000 railway wagons also engaged.

just before the world war II the principal activity was commercial only, storage and distribution. Now as all the world knows Belgium is essentially an industrial country and should therefore have been able long ago to participate fully in the industrial hydro carbon output, already products of great world demand. However, in the serious search to provide Antwerp port with secure elements of long-term traffic it was decided in 1948 to immediately undertake projects of development already off the drawing board, comprising the construction of deep water docks between the Hansa dock and the river Escaut, or Scheldt. These were projected with the end in view of providing an attractive site for the establishment of oil refineries with full facilities and ample expansion area.

In the short space of two years the new oil dock with water area of 125 acres, 3,200 m. of quays and a minimum water depth of 13.00 m. (43-ft.) to receive the oil tankers was constructed. To the west of the dock there is an area of 300 hectares (750 acres) of which half has been conceded to " Société Industrielle Belge des Pétroles " which commenced construction of the first refinery in March 1950, and started production in September 1951 since when the daily capacity is 6,000 tons. A second concession was granted of 100 hectares (250 acres), on the east of the dock (Fig. 8) to the " Esso Standard Refinery " which started erection of the plant May 1951 and was officially opened in production September 1953. Between these two refineries there is an area of 40 hectares (100 acres) abutting on the dock side set apart for the chemical industry, a by-product industry of the above refineries.

This imposing maturation of the port authorites' bold planning gives satisfaction in the added sense of security in an ample volume of regular traffic. It has also shown that still further extensions will soon be necessary.

There is another problem for harbour authorities which calls for special consideration—maybe stemmed from the military supply service during hostilities, that is specialisation and mechanisation. Every day one becomes aware of its importance in labour difficulties and even in the attitude of shippers and agents. The remarkable growth of road transport has not only been confined to the roads but now penetrates to the quaysides, and even the oldest method of transport inland, the waterways in Western Europe, have now assumed traffic proportions that require every consideration in the seaports—the termini of their voyages. In fact the problems of interior circulation related to the seaports imposes a duty on all port authorities to provide accommodation for their needs in all future extensions and to adapt as far as possible present layouts to suit conditions.

In a port like Antwerp with extensive inter-connection of docks serving the sea-going vessels and the inland traffic the circulation within the docks is more or less common to all vessels, large and small, with the exception that certain entrance locks are reserved for the latter. The configuration of the docks particularly in relation to the Albert Dock and the Albert Canal whilst favouring the water circulation traffic seriously impedes the land traffic, road and rail. This arises from the narrow channel at the head of the Leopold dock leading into the Albert dock (Fig. 3). Spanning this channel there are two bascule bridges, one at each end—that is about 350 m. apart. These bridges link the area south of the Hansa dock with the north section for road and rail. The point is this. The normal daily openings of these bridges is 35 for the passage of about 120 vessels and lighters. These manœuvres represent throughout the day a standing time of no less than 6 hours, which obviously is a serious interruption to land traffic. As the lighter traffic of the refineries tends to grow the situation will become worse. However to reduce this wasted time, whilst the future new extensions are being formulated, there is to be a more direct allocation of marine and fluvial services.

Present Extensions

For many years the Port Authority has considered that the Kruisschans Marine Lock into the river Escaut has not been adequate to cope with the development of the port, and the present day tonnage and volume of the traffic. The mean tonnage of vessels using the port has increased considerably and the traffic at this lock has also increased. The number of vessels of a length over 440-ft., which is about half the length of the existing lock, in 1937 represented only 10 per cent. of the locked traffic but in 1947 it rose to 30 per cent. The increase is still on the upgrade. This position was foreseen even as far back as 1913 when the expansion programme for the Hansa docks and lock chambers was reduced owing to lack of funds. At that time a second lock chamber of 400 m. (1,312-ft.) long was projected; however the necessity has now to be met and it is being proceeded with urgently. It will be north of the present lock with a length of 1,181-ft., width 147-ft. 8-in. and a draught of 37-ft. 7-in. It will be known as the Baudouin lock and will be completed in 1955.

The Future

It is usually hazardous to indulge in prognostication in ordinary times and most certainly in an epoch which is critical for Western Europe and, indeed, on the subject of the exploitation of ports, complex entities, sensitive to the influences of many economical and technical factors. The several pre-occupations that have been noted in relation to the actual evolution of the port's activities poses a few structural problems of which some have been already resolved. As for the rest in the near future it is almost certain that the following items must be undertaken.

(a) As a consequence of the increase in dimensions of vessels and specialisation and mechanisation of the quayside equipment it will be necessary to provide more berths alongside for general traffic equipped with up-to-date appliances. Besides, greater areas near the quays will be necessary for the deposit

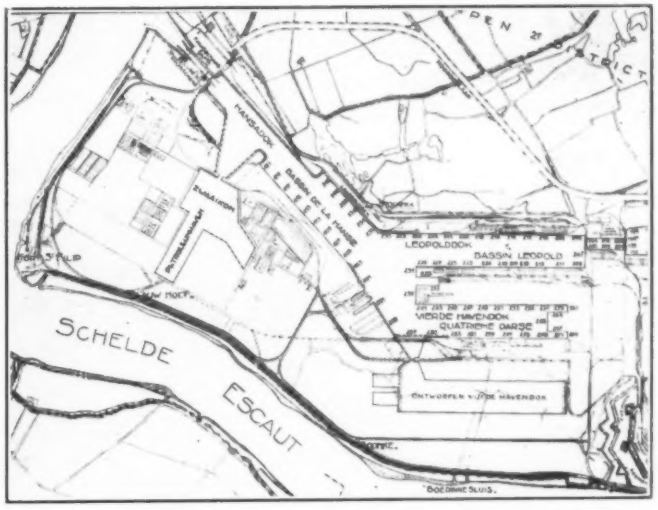


Fig. 8. Layout of the new oil port south of Hansa dock.

Timber Traffic at Southampton Docks

Important Item in Port's Cargo Trade

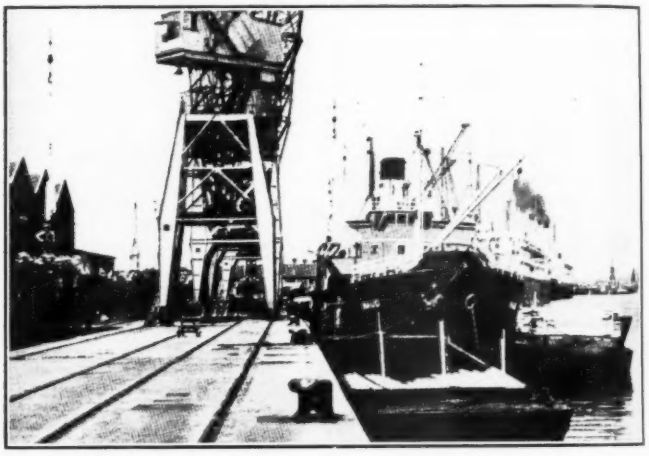
Although Southampton is not, comparatively speaking, a large timber port, this commodity forms an important item in the cargo trade of the docks, being imported principally from the Baltic, Canada and South America. The main varieties received are softwood deals battens and boards from Norway, Sweden and Russia (although since the war small quantities have been received from Yugo-Slavia and Corsica); and Douglas Fir, Hemlock, Balsam Pine, Red Cedar and Spruce from British Columbian ports. Other varieties, in smaller quantities, include Corsican Beech, Siberian Larchwood, Ramin Wood (from Sarawak, Borneo)—mostly used in the making of furniture—Maritime Pine, Ash, Elm and Beech from France; Dutch Bottoms—used in railway wagon construction—from Rotterdam, telegraph poles from Sweden and Finland, and Parana Pine from Brazil. Sleepers and crossings are also included in the consignments from British Columbia, and are transhipped to barge at the docks for British Railways' Civil Engineer's Depot at Redbridge for "pickling."

Modern Handling Facilities.

At the docks there are facilities for discharge and loading to rail or road either direct from ship or piled stacks. There is also a good range of open and covered storage space. The principal covered storage space is situated near Berths 40/1 in the Old Docks, the Ocean Shed (measuring 660-ft. by 100-ft.) being used for lighter wood goods and the nearby Gantry Shed for heavy timber. The latter shed measures 330-ft. by 60-ft. and allows of stacking up to 20-ft. It is primarily intended for the reception and storage of bulk timber and to facilitate handling is equipped with a 2-ton overhead gantry crane which serves the entire area of the building; a central rail and vehicular road, 11-ft. wide, is provided for loading to rail or road vehicle.

All berths used for the discharge of timber are equipped with double (and, in several instances, triple) rail tracks, a factor which contributes to rapid handling.

The ship's manifest is a summary of the cargo, giving the Bill of Lading number, consignee marks, the number of pieces in each Bill of Lading and number of standards. (A standard is the unit used for measuring timber and represents 165 cubic feet, or 23,760 lineal feet of 1-in. x 1-in.). The specification shows in detail the make-up of each Bill of Lading, with the number, length and size of the pieces. The stowage plan shows the disposition of the cargo on board and is a most useful document as it tells the stevedores the order of stowage. Each "parcel," as the consignments are referred to, when stowed on board is separated by paint markings so that, when discharging, each Bill of Lading can be worked to completion.



Timber being discharged overside and to railway trucks at the Itchen Quays, Southampton.

Disposal from the ship is carried out in accordance with merchants' orders and can be direct to rail or road, overside to barge or to water for rafting, landing to quay for sorting measuring and delivery to size, or for delivery to the timber sheds or open sites for storing and subsequent delivery.

At the timber sheds each Bill of Lading is unloaded from rail trucks, sorted to size and quality and stacked in close or stripped piles according to merchants' requirements. Delivery from stacks is at all times effected by measurement to rail or road vehicle according to merchants' orders.

At the New Docks there is a modern timber storage shed and sawmill, privately owned, occupying 2½ acres. The shed is 434-ft. long by 127-ft. wide, and the sawmill is equipped with the latest electrically - operated machinery, including band re - sawing machines, roller-feed saw benches, five-cutter planers and moulders.

The Port of Antwerp

(continued from previous page)

of bulk cargoes for which the equipment must be adapted to handle the particular materials.

(b) Encouragement to industrial firms to establish themselves within the port requires the preparation of suitable sites complete with dockside access and equipment.

(c) Roadways for lorry traffic are a necessity; they must wherever possible be carried alongside the berths and sheds.

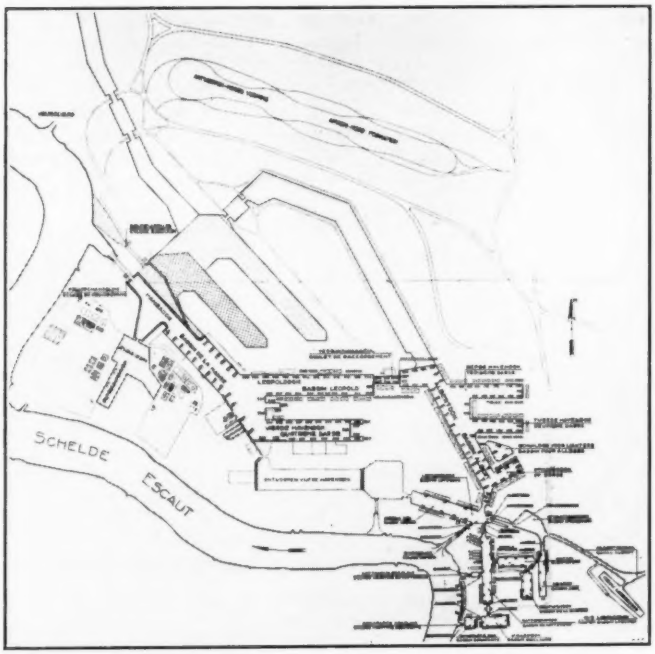


Fig. 9. Projected extensions to docks north of Hansa dock and south of fourth dock. The site of new Baudouin lock is also shown. This will be completed in 1955.

(d) The outline of the port's expansion programme is shown in Fig. 9 by the cross hatching of projected docks north of the Hansa dock. These docks when completed will form a loop and so facilitate the avoidance of bottlenecks in circulation. To the south the dash lines show the outline of another projected dock linking up the system to the south end of the Albert dock and to the Royers entrance lock. Should all these extensions materialise and the size and draughts of seagoing vessels increase at the same rate as they have done in the past three decades the provision of extra entrance locks will be a prime necessity.

Reverting to Mr. Leemans' remarks with which this report opens it is interesting and even instructive to note that the Port Administration maintains an efficient Publicity and Economic Information Service. Our thanks are due to the Port Authority and the London Agents, Messrs. W. Hall and Co. (London) Ltd. for information and assistance given. R.R.M.

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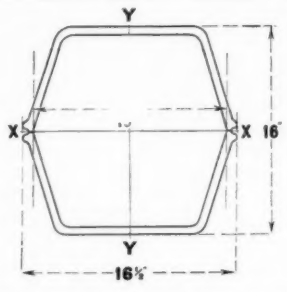

Weight of Rolled Section: 58.30 lbs. per ft.

Weight of Complete Column (including weld): 117.75 lbs. per ft.

About	Moment of Inertia (inches⁴)	Radius of Gyration (inches)	Section Modulus (inches³)
XX	1.214	5.95	151.75
YY	1.038	5.50	125.82

A lighter section (13" x 13") is also available as follows:

Weight of Rolled Section: 36.15 lbs. per ft.

Weight of Complete Column (including weld): 72.50 lbs. per ft.

XX	469.26	4.69	72.2
YY	381.33	4.23	58.7

THE PURPOSE behind the production of the Cargo Fleet Foundation Column is to provide engineers and structural designers with a steel section which can be adapted to a variety of modern uses at reasonable cost.

Briefly, this new multi-purpose product consists of two semi-hexagonal rolled steel sections specially designed for welding together to form a complete hexagonal column.

These columns are fabricated at Cargo Fleet and can be supplied in any lengths up to 120 feet. The most modern shot blasting equipment has been installed to ensure efficient protection from corrosion.

ADVANTAGES

ECONOMY IN USE. As load-bearing columns, particularly on long lengths, they show distinct economies over other forms of construction.

EASE IN HANDLING. In relation to their strength these columns are light in weight and easily transportable.

SAVING IN TRANSPORT & STORAGE SPACE. The columns "nest" for transportation and shipment. Compared with pre-fabricated columns of equal size they show a tremendous saving in space—both in transit and on site.

APPLICATIONS

DOCK & HARBOUR CONSTRUCTION. Cargo Fleet Foundation Columns are particularly adapted for use where piling construction is required. The properties of these Columns are superior for the work for which they are designed as compared with other methods of piling construction.

BRIDGE & CAISSON WORK. For bridge foundations, piers and caissons, Cargo Fleet Foundation Columns are a distinct advance on all other types of riveted or bolted columns. Erection is simplified, strength is unimpaired by drilling and the absence of joints reduces damage by corrosion.

STRUCTURAL WORK. Cargo Fleet Foundation Columns have a wide range of uses both for piled foundations and for superstructure columns combining lightness in weight with maximum load-bearing capacity.

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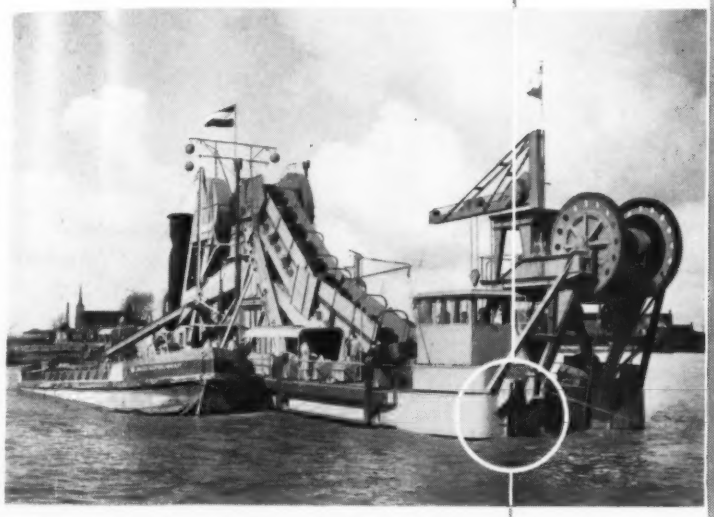
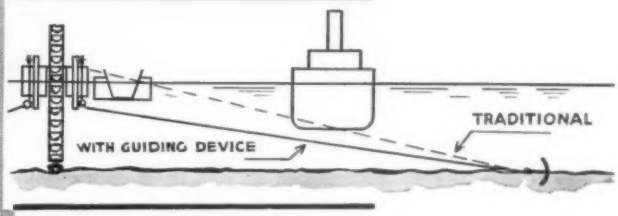
NEW GUIDING DEVICE FOR DREDGER CABLES ALLOWS SHIPS TO PASS UNHINDERED, EVEN IN CONFINED AREAS.



Tugs and barges pass freely, too. Hauling alongside the dredger is much easier now. Rectangular bilges no longer threaten dredger side-cables

In the design stage of a new dredger the engineers of **I.H.C. HOLLAND** take nothing for granted. All details are considered anew, and so established practice has very often to give way for a new approach.
In the newly-built bucket dredger "Hercules" there is one item among the many well-tried accessories which clearly illustrates this point. The anchoring cables of the "Hercules" are led from the winches to the outside over a special guiding device which takes the cables down well below the waterline.
Thus they do not obstruct passing ships, which is of great importance in ports and other restricted areas.



W.BINK

This is just one small example of the many new ideas which are continually being applied in the complete line of dredging equipment built by **I.H.C. HOLLAND.**
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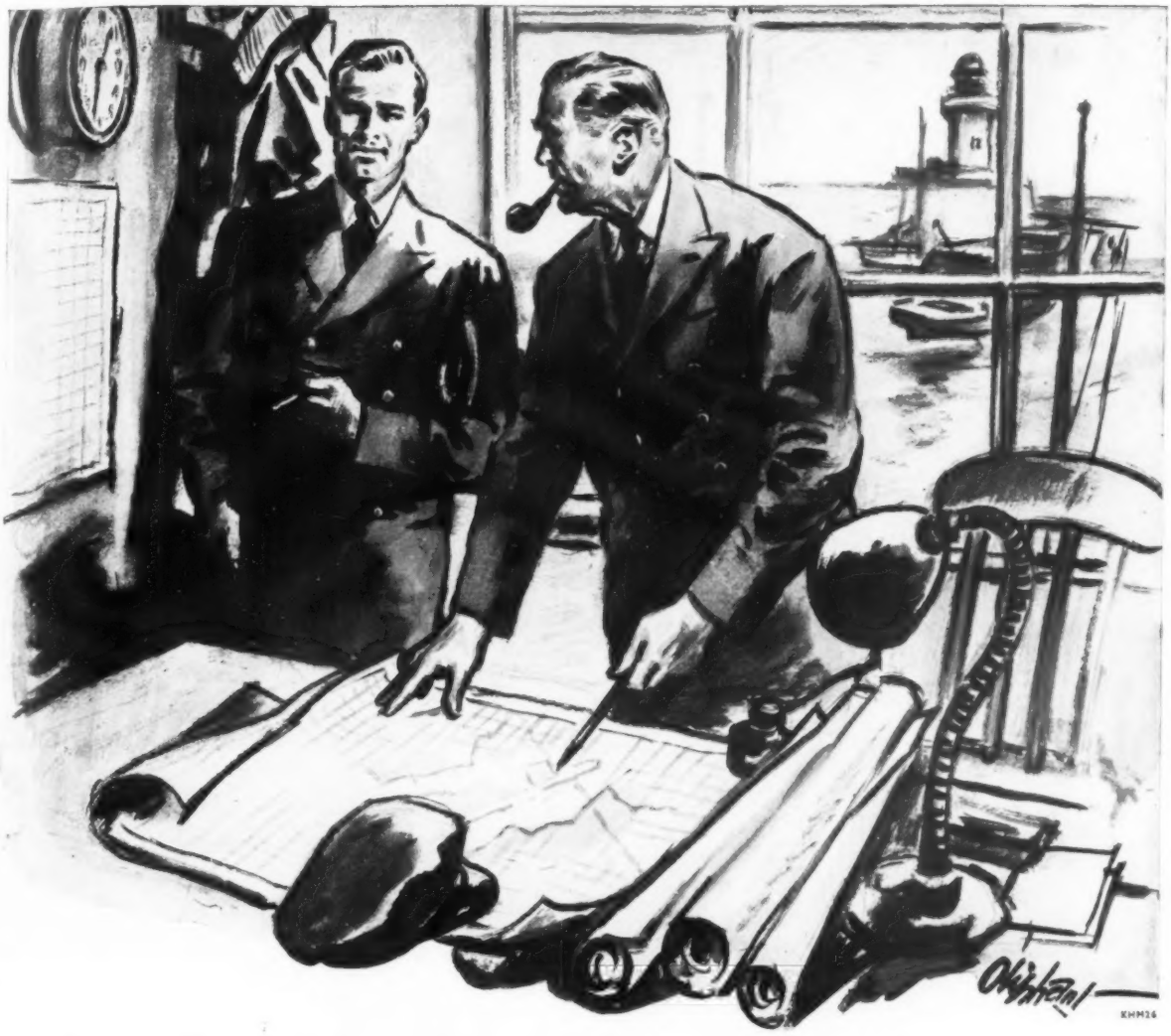
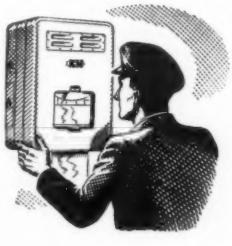


See that shoal by No. 3 Buoy!

That's getting serious. There'll barely be two fathoms there at low tide—means a dredging job.

I quite agree.

Amazing how these charts show up the changes to the channel. Kelvin Hughes did the survey, didn't they?



That's right — Contract Survey they call it. Their Surveyors have certainly done a thorough job with their special equipment.

We'd better get them to survey again after dredging, then we'll have up-to-date charts.

Yes, and periodic surveys in the future so we can keep an eye on the channel.

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The Controversy on Ship Tonnage Measurement

Present System Detrimental to Port Authorities

By A.G.C.

A SYSTEM of internal measurement of ships, which produced the tonnage on which ship's dock and harbour dues were paid in this country, was brought into operation by the Merchant Shipping Act of 1854. Devised in 1852, it was known as Moorsom's tonnage rules, after the secretary of the committee or commission that had compiled it.

For a hundred years controversy over these rules has arisen from time to time—mostly between dock and harbour authorities and shipping companies—but they have stood the test of time and it does not appear likely that they will be displaced in the immediate future.

Tonnage measurement was in the news in 1953 when Sweden decided to adopt the English system. It is to start on the 1st January, 1955. When this change takes place it is expected that the net register tonnage of Swedish ships will be reduced by about 23 per cent., necessitating an increase of about 30 per cent. on the dues levied by Swedish ports to bring in the same revenue as before. This appears to be the first result of the International Conference held in Oslo in June, 1947, which was referred to in an article in the August, 1953, issue of this Journal. Although Moorsom's tonnage measurement rules, which are the basis of The Merchant Shipping Acts of 1854 and 1894, and have been adopted by all maritime nations, they have been interpreted in many ways.

While it is natural that shipping companies should take advantage of the elasticity in tonnage regulations, to benefit by deductions from the gross tonnage in order to produce a ship with the smallest net register tonnage, such an achievement may mean a loss of revenue to dock and harbour authorities who cannot alter tonnage dues, which are levied on net register tonnage, to fit individual ships.

In 1888 the following circular letter or agreement was sent to shipowners in Great Britain for signature by those who desired a Mr. Pirrie's services.

Guildhall Chambers,
Newcastle-on-Tyne.

To Mr. R. R. Pirrie.

Sir,

Please survey our steamers with a view to obtaining for us a reduction of net register tonnage, and in cases where you are able to effect a reduction without structural alterations or delay to steamers, we will pay you the sum of———per ton on each ton reduced, no fee to be paid to you if you are unable to effect a reduction.

We undertake not to divulge to others any information you may give us.

Yours truly,

Early in March, 1889, a Mr. Norwood headed a docks deputation to the President of the Board of Trade to protest about the faulty wording in the Act of 1867. It appeared that, through the non-repeal of the Section of the Merchant Shipping Act of 1854 which exempted the crew space from inclusion in the net register tonnage, a double reduction was being given for the space; one for the 1854 Act and one for the 1867 Act. Here it should be explained that although tonnage dues are levied on the net register tonnage of ships for wet docks, in the case of dry docks gross tonnage is the basis of charges.

The controversy on tonnage measurement arises from allowances made through deductions from tonnage as compensation for non-revenue earning spaces in ships. There appears to have been little divergence of opinion before the advent of steamships. For centuries it was agreed that the internal capacity of a ship was the fairest measure of her earning powers, and one on which dock and harbour dues should be assessed. In sailing ships it was simple. There was only one tonnage; the gross register tonnage, and that was recorded in the early publications of Lloyds Register. Even when, in the 1860's, two tonnages were shown for sailing ships—the gross and the net register—there was only about 100 tons difference between them, and nobody minded an allowance for crew's accommodation.

Deduction for Engine Room Space.

Perhaps the greatest controversy has arisen over the tonnage deduction for the space occupied by the propelling power of a ship. In the early days of steamships their owners were in severe competition with the well established sailing ships. Bunkering stations were few and far apart. Large quantities of bunker coal had to be carried for the boiler furnaces of steamships. Struggling steamship owners appealed for help. They said that large parts of the internal measurement of their ships were occupied by "non-revenue" earning, propelling-power space, whereas the propelling power space of the sailing ships was aloft and not included in the tonnage measurement. So it was agreed that tonnage deduction allowance for machinery, boiler space and bunkers should be made. And to rub it into the sailing ship owners, although the steamers' coal bunkers were included in the tonnage deduction, the spaces occupied by sail lockers in sailing ships were not. No thought seemed to be given to dock and harbour owners, whose costs were in no way diminished because the means of propulsion had descended into the vessels' hulls.

It was not so much the allowance for the propelling power of steamships that seemed unfair to dock owners as its method of computation. This was, and is, a percentage of the gross tonnage of a ship, which is deducted from the gross tonnage to reduce it to net register tonnage. Section 78 of The Merchant Shipping Act, 1894, states that the space occupied by the engine room, shaft tunnel, and such light and air spaces as the owner wishes to have included, are to be measured. If this measurement is above 13 per cent. and under 20 per cent. of the vessel's gross tonnage, then the deduction allowed from the gross tonnage is 32 per cent. Should the measurement be 13 per cent. or under, or 20 per cent. or over of the gross tonnage then the deduction from the gross tonnage is $1\frac{3}{4}$ times the tonnage measurement of the engine room.

This tonnage rule was laid down in Section 78 of the Merchant Shipping Act 1894. But under section 87 of the same Act ports could apply for powers to levy dues on a fixed proportion or percentage of the gross tonnage of a ship. These powers were obtained by special Acts of Parliament dealt with by Parliamentary Committees. In 1905 it was reported that such powers had been given to 32 ports and dues had been fixed on a percentage of from $33\frac{1}{3}$ per cent. to 50 per cent. of the gross tonnage of the vessels concerned. As a rule these powers were only given to ports doing an inconsiderable trade in order to relieve their financial difficulties.

Board of Trade Enquiry.

It was in 1904 that the Mersey Docks and Harbour Board and the Cardiff Docks applied for powers to reduce the percentage that certain ships were deducting from the gross tonnage to compute the net register tonnage. The Parliamentary Committees considering these bills did not take objection to them because grievances did not exist, but because in their opinion, the remedy sought did not fully protect the crew and working spaces, and was therefore against the public interests. It was also considered that the subject was too large to be dealt with by any private Bill Committee, however competent.

The outcome was that a committee was appointed by the Board of Trade on the 24th January, 1905, to enquire:—

(1) Whether the operation of section 78 of the Merchant Shipping Act of 1894 tends to produce in any class of ship a disproportionally low register tonnage in comparison with the gross tonnage, or not, and, if so, to report what amendments may be required by way of fixing a limit to the deduction for propelling power which shall be reasonable and equable.

(2) Also whether it is desirable to amend Section 87 for the purpose of securing a uniform basis upon which rates are to be levied by various bodies dealt with in Section 87 and, if so, what amendments may be required in this section.

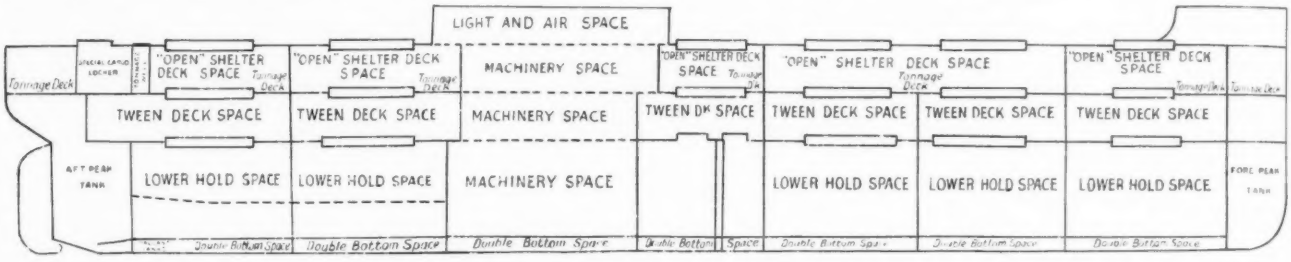
Ship Tonnage Measurement—continued

The Committee dealt with the complaint of the Mersey Docks and Harbour Board against the Cunard Steamship Company with reference to their new cross-Atlantic passenger liners. Owing to their increased speed their engine rooms had become larger and the $1\frac{3}{4}$ times the size of the engine room tonnage allowance reduced their net register tonnage, on which dock dues were paid, considerably. Five of the Cunard liners had a gross tonnage of 58,271 and a net tonnage of 36,746, while four had a gross tonnage of 42,148, and a net register tonnage of 17,336.

It was said that while the Harbour Board was asked to provide berths for liners of 700 or 800-ft. in length, the percentage of net tonnage to gross tonnage was steadily falling. This meant that although the shipowners had bigger ships built, the tendency was to pay less in proportion for the use of the docks.

The late Mr. Bonar Law was the chairman of this Committee, which held 24 meetings and examined witnesses representing the interests of shipowners and dock owners. The Committee also recived statements from various dock and harbour authorities, shipowners and associations interested in the subject. Their report ports to suffer financial loss. The other member gave that may be considered a valuable and logical contribution. He stated that, in his opinion, the system of assessing dues should be based on services rendered to ships and the accommodation provided by dock and harbour authorities, and any departure from the tonnage measurement system then in force should be replaced by a method taking into account the length, breadth and draft of ships. In other words, on the water space defined by the extreme dimensions of the immersed part of a vessel when floating at her load line. Later in this article more will be written on this method of assessing charges. This member was also of the opinion that special arrangements should be made for the payment of dues by companies owning ships of great speed in which very large deductions are made for space occupied by machinery, boilers and coal.

The four members of the Committee who dissented from the main report—among them the famous naval architect, the late Professor J. H. Biles—pointed out that the inadequate return received by dock and harbour authorities in the cases under review resulted from an inequitable payment as between ship and ship.



Stowage space of an "open" shelter-deck cargo ship.

included some additional remarks by two of its signatories and a minority report by four of its members who disagreed and refused to sign the report.

The majority report stated that, under section 78 of the Merchant Shipping Act of 1894, the allowance for space occupied by the propelling power of steamers does, in some cases, produce a net register tonnage which is disproportionately low in comparison with the gross tonnage, and dues charged on this low register tonnage do not give adequate return to dock and harbour authorities for the accommodation provided by them. It also involves inequality between ship and ship. Two classes of ship alleged to have this relatively low register tonnage were certain coasting and cross-channel steamers, and fast ocean-going passenger liners.

The Committee also pointed out in their report that since 1901, when the Board of Trade amended paragraph 8 of their instructions relating to the measurement of ships in order to obviate the recurrence of low register tonnages, such cases had been few. Regarding fast ocean-going passenger liners, in which the deduction for the engine room space is necessarily large, and tends to increase as speeds increase, the Committee urged that such cases were comparatively few, and that these liners were owned by companies owning a large number of steamers of comparatively high net register tonnage. The owners had stated, that the vessels referred to in the two classes which were being examined, made more frequent voyages and had shorter stays in dock than others. This provided compensation for their relatively low net tonnage.

Other points the Committee made were that, although the existing tonnage law was open to criticism in some respects, and was by no means an ideal basis for assessing dues, it has operated successfully on the whole, since it was established. It has favoured free expansion in particular trades, and nas encouraged the provision of ample space for the accommodation of crews and working machinery. Any change, the Committee reported, would raise questions of difficulty and perplexity further complicated by the fact that the principal maritime powers have adopted the British system of measuring ships. It might even affect adversely British shipping and trade.

In conclusion, the Committee reported, that sufficiently strong reasons to make a change in sections 78 or 87 did not exist. This was the majority decision of eight members. Of the two members who made additional statements, one repeated what the Committee had already reported: that a low register tonnage caused some They also called attention to the fact that expenditure upon dock plant speeds up the turn-round of vessels, and adds to the efficiency of a ship as a cargo-carrying unit. It cannot therefore be claimed that the reduction in time of a ship in port, which has been achieved through considerable expenditure on the part of dock owners, should be associated with a reduced payment of tonnage dues on the part of the shipowner who is so much benefited.

The minority also pointed out that in the past the Parliamentary Committees, which have considered Bills promoted by dock and harbour authorities to give them power to levy dues on at least 50 per cent. of the gross tonnage, have found them proved. The most important statement made by the four dissenting members was that the principle set forth in Section 78 (1) (b) Merchant Shipping Act, 1894, is that in proportion to space actually occupied by, and necessary for, the working of the machinery, so is the deduction for propelling power to increase or diminish; but, in prescribing no limit to that deduction, the Section has rendered it possible for vessels of certain types, and others designed for special trades, to obtain so large a deduction as to result in a register tonnage which falls materially below most of the proportions of gross tonnage allowed by Parliament to ports which have in the past applied for special levying powers. It therefore seems reasonable to introduce into Section 78 (1) (1b) a proviso regulating the deduction for propelling power so as to prevent this result being brought about. This they recommended in the form of a fixed percentage limit, to be deducted from the gross tonnage for the engine room space allowance, by an additional clause at the end of the Section. This recommendation was the crux of the whole inquiry and it is interesting to note that, in spite of it being put forward in the minority report, it was included in an amendment to the Merchant Shipping Act, 1907, when the maximum tonnage reduction for engine room allowance was fixed at 55 per cent. of the gross tonnage of the ship. Considering that the deduction had, in some cases, been as high as 82.8 per cent., it may be considered that this was a step in the right direction. A case was mentioned some years ago of a coal burning steamer of which the size of the engine room was a little over 13 per cent. of the gross tonnage. She therefore received an allowance of 32 per cent., the balance of 19 per cent. being an allowance for coal bunkers. But her bunkers were all situated within the measurement of her engine room.

Ship Tonnage Measurement—continued

The Open Shelter Deck.

The controversy on tonnage measurement has not been confined to the allowance for engine rooms; the " open " shelter deck space has also been included. The tonnages recorded in Lloyds Register, and similar publications, are the gross tonnage, the under deck tonnage, and the net register tonnage. In all these cases a ton is a unit of volume contained in a 100 cubic feet.

The **Tonnage Deck** is the upper deck in all ships which have less than three decks, and the second deck from below in all other ships.

Gross Tonnage comprises the exact measurement of all spaces below the tonnage deck, as well as all permanently closed and covered in spaces on that deck. " Open " shelter deck space available for the stowage of cargo, and any closed in space fitted with machinery (not the main engine room), wheel houses and galleys are not included, nor yet is any building erected on the upper deck for the shelter of deck passengers. The space included in the double bottom of the ship is also exempt, although when oil bunkers are carried in the double bottom tanks the space thus occupied is measured and added to the net register tonnage.

Under Deck Tonnage is the total tonnage measured up to the tonnage deck but not including the double bottom space.

Net Register Tonnage is obtained by deducting the measurement of certain spaces from the gross tonnage. These are known as non-revenue earning and include: the propelling power space, the accommodation provided for the master and crew, navigation rooms, boatswains lockers, paint and oil lockers, and certain water ballast tanks.

These deductions are governed by the Merchant Shipping Act 1894 and its later amendments. Other nations, in computing the net register tonnage, have various spaces deducted, and in foreign ships, percentage allowances vary. The " open " shelter deck, although not included in a ship's tonnage, is available for the stowage and carriage of cargo. The word " open " appears to be a misnomer, for an " open " shelter deck ship is an awning deck ship with one or more openings which do not comply with the Ministry of Transport's (previously the Board of Trade's) regulations for permanently closing. These openings are often tonnage wells, abaft the after hatch, which are fitted with hatchways of a specified size, and hatch coamings of a limited height. The securing of a hatchway must be of a temporary nature, but in spite of this it is satisfactory in the matter of preventing water getting into the shelter deck.

In a cargo vessel of 450-ft. in length, the stowage space in the " open " shelter deck amounts to about 1,500 tons. Under Article 85, of the Merchant Shipping Act of 1894, the cubical dimensions of any cargo carried in " open " shelter decks must be measured and added to the net register tonnage for computing dock dues. But when an " open " shelter deck space is empty, no charge is made on that space. It would seem as logical for a vessel in ballast with no cargo in her holds, to pay no dues at all. In the Suez Canal Company's tonnage regulations it is laid down that once a ship passes through the canal with cargo in her " open " shelter deck, she will, as long as she remains under the same ownership, always pay dues on that measurement whether she carries cargo there or not.

It should not be concluded that " open " shelter deck ships are built for the sole purpose of obtaining relief from dock dues. They are a special type of vessel suitable for carrying light, bulky packages. In 1953 a well-known London passenger liner company had three cargo ships built to their requirements. The first, which had a gross tonnage of 10,000, had a length of 469-ft. and a breadth of 64-ft. The other two were sister ships of the " open " shelter deck type, and although they were each of a smaller tonnage, 9,290 tons gross, they were of larger dimensions, 490-ft. in length by 69-ft. in breadth, and they each carried 1,440 measurement tons more cargo than the first ship.

Tonnage Anomalies.

Earlier in this article it has been explained how the allowance for engine room space originated. How other exemptions from tonnage inclusion in the British tonnage measurement rules have arisen are just as interesting. One such rule stipulates that no addition shall be made to the gross tonnage in the case of buildings above the upper deck, erected for the shelter of deck passengers. It appears that this exemption originated from the necessity of providing shelter for the drovers employed in vessels carrying cattle, and has since been extended to the accommodation of passengers on short voyages.

Another example of exemptions which went beyond the original intention concerns Section 3 (a) of the British Instructions as to the tonnage measurement of ships. This section deals with " closed in spaces which may be exempted " and states: " The following exemptions to the general rule of measuring all closed-in or weather protected spaces are allowed: (a) any closed-in space or spaces solely appropriated to and fitted with machinery." This referred to steam steering houses, capstans and wireless spaces, etc., and it could never have been contemplated that it would be extended to a factory built on a whaler's deck.

Differences in foreign and British tonnage measurements are well illustrated in a comparison with those of the Suez and Panama Canals.

Tonnage	British	Suez	Panama
Gross	6,009	7,765	8,571
Under Deck	5,659	5,452	5,736
Net Register	3,753	5,681	6,087

The main causes of the differences are:—

(1) inclusion in the net register tonnage of practically all the so called " open " shelter deck spaces by the Suez and Panama systems, but not by the British method;

(2) difference in the computation of the allowances for propelling power space;

(3) deductions for water ballast tanks such as fore peaks, after peaks, and deep tanks, which are allowed under the British rules, but not under those of the Suez or Panama Canal Authorities.

After the First World War variations in the application of tonnage measurement received the attention of the League of Nations and they set up a Technical Committee on Maritime Tonnage Measurement. In 1928 this Committee issued a report " on the differences in the existing rules for tonnage measurement and in the application thereof," and " the establishment of a uniform method of tonnage measurement." This uniform method was based on the British tonnage rules. The outcome of the work of the Technical Committee was the " Draft Regulations for Tonnage Measurement of Ships, 1931," which was distributed to all maritime countries. It met with no success.

At a meeting of the United Nations Transport and Communications Commission in 1951, a draft resolution was accepted stating that the unification of maritime tonnage measurement should be among the first problems to be considered by the Inter-Governmental Maritime Consultative Organisation as soon as it started to function. At the time of writing it has not started. One interesting outcome of this new effort with regard to tonnage measurement is the British proposal for modification of the engine room allowances. The case taken is where the measurement of the engine room is 13 per cent. or under of the vessels' gross tonnage. At present the deduction allowed for such a ship is $1\frac{3}{4}$ times the measurement of her engine room. This is thought to be inadequate in shipping circles, and has the disadvantage of tempting an owner to build an engine room which measures over 13 per cent. of the ship's gross tonnage in order to obtain a 32 per cent. of the gross tonnage reduction. The suggestion is that a sliding scale be introduced on the following basis. That a vessel with an engine room of 13 per cent. of the ship's gross tonnage be allowed a deduction of 32 per cent. of the gross tonnage; one with an engine room of 12 per cent. a deduction of 12/13ths of 32 per cent., and so on.

This very case had come up for consideration by the League of Nations Tonnage Committee 20 years before, and some members then recommended a similar sliding scale. In the case of an engine room of from 11 to 13 per cent. of the gross tonnage, it was recommended that a deduction of 27 per cent. of the gross tonnage be made, and from 9 to 11 per cent. of the gross tonnage, a 22 per cent. deduction of the gross tonnage was to be given. Another proposal of this Committee, to remove hardships in the case of vessels with a small engine room, was to replace the factor 1.75 by 2.4 for vessels where machinery space did not exceed 13 per cent. of the ship's gross tonnage. This meant that such a vessel would have a deduction from the gross tonnage of 2.4 times the actual

Ship Tonnage Measurement—continued

measurement of her engine room. Nothing came of these suggestions. It is interesting to read the final conclusion of the League of Nations Technical Committee on Maritime Tonnage Measurement:

" The Committee thoroughly examined the question of propelling power allowance, and unanimously agreed that the existing percentage, or British system, presented certain anomalies. It was, however, agreed that the substitution of any other system would also present difficulties.

" Taking into consideration the fact that the existing system is adopted by practically all maritime nations, that a very large number of vessels have been dealt with accordingly, and that considerable confusion would result from the adoption of a new system, the Committee decided to recommend that no change should at present be made in the existing practice of determining the propelling power allowance."

The League of Nations Technical Committee also reported on " open " shelter decks. They discussed the advisability of including all, or exempting all, superstructures in the gross tonnage and finally reported that: " (1) There was no possibility of finding a system which would satisfy all possible contingencies; (2) The present system had become an internationally accepted fact, and any alteration in the principles governing it would entail a very large amount of work for the various authorities concerned; (3) Nevertheless, it was considered that cases of unequal treatment as between ship and ship would inevitably occur. In this respect, the Committee desires once more to refer to the solution provided in Article 85 of the British Merchant Shipping Act, 1894, to cover instances of cargo carried in open spaces In any event, the Committee would recommend that the dimensions and the capacity of the various open spaces should be marked on the national tonnage certificate."

Alternatives for Tonnage Measurement.

Mr. N. Gustaf Nilssen, who was one of the signatories to the League of Nations Tonnage Measurement report, later contributed a paper to the Institution of Naval Architects in which he suggested that displacement tonnage should be the basis of Dock and Harbour dues on ships. He recommended the displacement tonnage at 85 per cent. of a vessel's moulded depth, as given by the International Load Line Convention in 1932. This could readily be obtained because all vessels of 150 tons and over, engaged in international voyages, were assigned this displacement by the Load Line Convention, and all new vessels were to be provided with it.

While on the subject of the International Load Line Convention of 1932, it was then that British oil tankers and timber deck cargo carriers were assigned lesser freeboards which enabled them to load deeper. A tanker of 450-ft. in length, loaded 15-in. deeper, increases her cargo capacity by about 750 tons. Even the "open" shelter deck vessels, in some cases, gains to the extent of a few inches, giving a 450-ft. cargo liner an increased carrying capacity of about 200 tons. The point is that the net register tonnage of these ships remained the same in spite of the deeper draft and the increased cargo carried. In Sweden, at that time, several shelter deck cargo ships were converted to " open " shelter deck vessels without considerable change in the freeboard, but with a decrease of 1,000 tons in each case in their net register tonnage.

Mr. Nilssen's suggestion, perhaps, came nearer to the solution of treating all ships fairly, and would abolish exemptions and deductions. A vessel displaces a volume of water equal to her own weight and the weight of everything on board. This is the displacement tonnage. It shows a proportionate increase in increased draft by the addition of cargo; by increased length and breadth, and by additional decks built up for passengers. The displacement tonnage at any state of loading can be ascertained by relating the ship's mean draft to the displacement scale on board the ship. It may be considered unfair to charge a ship dock dues on her loaded displacement when she is not in a position to obtain full cargoes. If that is so it should offer no difficulties, as under the present system of charging, special dock dues are allowed on part cargoes. On the other hand it would not be impossible, although it would raise difficulties, to levy dock dues on the mean displacement of a ship when arriving and leaving.

The greatest difficulty of all would be in the changeover. Some types of ships would benefit, others would lose. The following examples show the various tonnages of three ships that were in dock together recently. The passenger liners are, of course, passenger and cargo carriers. This shows what the changes would mean.

Passenger Liner A	Cargo Liner	Passenger Liner B
Length 630-ft.	443-ft.	6[illegible]-ft.
Breadth 80-ft.	58-ft.	7[illegible]-ft.
Gross Tonnage 22,547 tons ...	7,049 tons	19,941 tons
Under Deck Tonnage 12,675 tons ...	6,669 tons	12,120 tons
Net Register Tonnage 13,620 tons	4,511 tons	12,027 tons
Deadweight 9,973 tons	11,430 tons	16,350 tons
Light Displacement 17,583 tons ...	4,503 tons	16,300 tons
Loaded Displacement 27, 556 tons ...	15,875 tons	26,650 tons
Light Draft 20-ft. 2-in.	9-ft. 3-in.	20-ft. 4-in.
Loaded Draft 29-ft. 2-in.	28-ft. 3-in.	30-ft. 2-in.

Deadweight as a factor on which to levy dock dues, has not been mentioned. From the above it can be seen that the cargo liner with a net register tonnage of 4,511 tons has a deadweight of 11,430, whereas the passenger liner with 13,620 tons net register tonnage has a lesser deadweight of 9,973 tons. Deadweight may be a good factor in ports where only bulk cargoes are handled and to which no passenger vessels go.

It will also be seen that the net register tonnage of each of the passenger liners is about three times as much as that of the cargo liner, while the loaded displacement of the passenger liner is less than twice that of the cargo liner. It may be considered that passenger liners are a greater expense than cargo liners to a dock and harbour authority. Deeper docks are required for them and in some cases new dry docks have to be built to accommodate them as they increase in size. Passenger Landing Stages have to be provided for their use, and additional facilities provided at their berths. Under any new method of assessing charges these extra facilities would have to be paid for separately by the vessels which benefited by their provision.

The years pass on and every alteration or addition to the British Tonnage Rules appears to be in favour of shipowners. While it is true that the dock and harbour authorities can apply for powers to increase their charges, it is obvious that inequalities in charges between ship and ship exist. Committees set up to enquire into these matters agree that this is so, but they also state that any change would raise questions of complexity and difficulty. The League of Nations Tonnage Committee went further: they stated that there was no possibility of finding a system that would satisfy all contingencies. Only one thing seems sure. The present system of tonnage measurement will always lead to controversy.

Swedish Discussions on Oil Pollution.

The problem of oily water at sea was discussed at a conference held last month at the Swedish Board of Trade in Stockholm. Those attending the meeting included representatives of the authorities affected, shipowners, port authorities, shipyards, oil companies, ships' officers and the associations concerned with the preservation of scenery and bird and animal life. The discussion was largely based upon the British report on the subject, and it was agreed that the problem could not be solved without international co-operation. While awaiting the proposed international conference and the results of an international agreement, it was suggested that provisional steps should be taken, such as the provision of special tanks and separators on board ship, and facilities ashore for dealing with oil residues and oily water from ships, necessitating measures by ports shipyards and oil companies. All present were agreed on the need for continued co-operation with the Swedish Board of Trade with a view to preparing for the proposed international conference.

Extensions at the Port of Ciudad Trujillo.

A number of improvements are to be undertaken at the Port of Ciudad Trujillo, Dominican Republic. The present breakwater is to be extended by 500-ft. and a second breakwater 1,500-ft. long is to be constructed in a north-south direction. When this work has been completed, it is anticipated that the swell within the harbour will be reduced to small proportions. The entrance channel is to be dredged to a depth of 36-ft., and a mooring berth for large vessels is to be provided on the Peninsula San Souci, which faces the city. The cost of all the work is estimated at $7½ million.

New Timber Storage Shed at Hull

Notable Example of Modern Technique

On a Hull dock site severely damaged by enemy air-raids during the Second World War a timber storage shed covering an area of one and two-thirds acres has been built for the firm of Horsley, Smith & Co., Ltd.

The sheds destroyed by enemy action in May, 1941, and nearly 30 years old, were of redwood and Douglas fir creosoted under pressure with, in some cases, supporting columns of pitch pine. Except for some slight deterioration near the ground, they were in a perfect state of preservation. They had never required painting and their annual maintenance cost was negligible. Constructional timber (excluding side cladding) had amounted to 50.5 standards per acre and 134 columns per acre had been required. Height was 22-ft. to the eaves.

The new shed, named the "Coronation Shed," is 440-ft. in length, 163-ft. in width and has clear, unrestricted height throughout of 25-ft., with only 14 internal columns, 55-ft. apart.

The main columns are 27-ft. 6-in. long and support 2,750 super feet of roof each equivalent to a design load of some 35 tons. They are built up of 8-in. x 8-in. members spaced apart to give a 24-in. square column.

The secondary girders, spanning 55-ft., are set at 6-ft. 3-in. centres to act as trussed purlins carrying reinforced troughing as the roof covering.

The constructional timber required (excluding side cladding) was 46.4 standards per covered acre as compared with 50.5 standards in the pre-war sheds, and this in spite of the fact that only 22 columns were needed per covered acre as against 134 in the old sheds.

Railway lines serving the new shed are under cover so that the gangs engaged in piling away the wood will be able to work in all weathers.

The advantages of Timber Construction.

As the site adjoins the River Humber it was estimated that a steel building subjected to the corrosive action of the sea air and the industrial atmosphere would require painting every four or five years, at an approximate cost of £1,500. A timber shed, on the other hand, would not require painting or other maintenance, and it was found that building costs were as economical as those of a comparable steel building.

Having agreed that timber could be used to advantage it was decided that basic considerations would be the application of Structural Theory instead of the old rule of thumb methods largely used in the past for the erection of storage sheds on Victoria Dock. The timber selected was Douglas fir graded for working stresses of the order of 1,200 lbs. per square inch.

The structure was designed in accordance with the British Standard Code of Practice C.P.112 "The Structural Use of Timber in Buildings."

View showing main framework completed. The bracing members between the secondary girders are being fixed from a plank scaffold supported on the frame itself.

View of the almost completed shed. The whole of the roof framing is contained within a depth of some 6-ft. An apron of asbestos sheeting has still to be fixed to protect the outer main girders from the weather.

The approximate cost per cu. ft., based on the tenders received, was 3½d. for the shed complete. The amount of timber used, including all but the side cladding, was 79 standards, representing 1.1 standards per 1,000-ft. super. The foundations to the columns are of reinforced concrete extending a minimum of 12-in. above ground level to prevent water being held against the timber columns.

One of the chief factors allowing speedy erection has been the repetitive form of construction from the foundations upwards

Resistance to Fire.

When considering fire hazard there was no hesitation in using timber in preference to other possible structural materials. Often where complete collapse has occurred in a steel framed building because of fire, this has not been the case in timber framed roofs: the main structure of heavier timbers has been only partially burnt away.

The layout of the shed has been so planned that the structure is accessible from all sides and a fire engine can be driven down the centre rail and road track, which together are 43-ft. wide, with a clear working height of 28-ft. With the River Humber only 30 yards away, fire risk has been reduced to a minimum.

Ease of Erection

The whole of the erection was carried out without difficulty by an entirely local labour force.

The columns, main beams and purlin sections were erected by crane, the columns taking an average of 20 minutes each from lifting to plumbing and securing, the main 48-ft. girders taking an average of 15 minutes each.

The columns and roof sections were set out and fabricated at Chesterfield to detailed designs prepared by Boltwood Engineering Limited; the architects were Messrs. Gelder & Kitchen and the building contractors Messrs. Houlton & Grant Limited.

Improvements at Shoreham Harbour.

It was announced at a recent meeting of the Shoreham Harbour Trustees that preliminary work on the £1,750,000 improvement scheme at the port is to begin almost immediately and the main work will start in the spring. A contract has been signed with Peter Lind & Co., Ltd., London, and it is expected the work will be completed in 1956.

The improvements, which are being undertaken in conjunction with the British Electricity Authority, provide for lengthening the breakwater to 500-ft., widening the entrance from 176-ft. to 450-ft. and deepening the harbour by five or six feet so that it will be accessible for vessels up to 4,000 tons. Seventy years ago the port was importing 100,000 tons of commodities a year, now the figure is 1,250,000 tons.

The Harbour Trustees have also decided to seek Ministry of Transport approval for the borrowing of £100,000 for 15 years for the self-propelled bucket dredger which they have ordered from N.V. Verschure & Co.'s Scheepswerf en Machinefabriek, Amsterdam. The tender for the vessel, which will be 125-ft. in length, was reported to be just over £132,000.

Ship Types and Future Tendencies

Probable Trends in Technical Developments

On 17th December last, a lecture on the above-mentioned subject was delivered to the London and District Association of the Institute of Chartered Shipbrokers by Mr. A. C. Hardy, B.Sc., M.I.N.A., who is an executive of the International Cargo Handling Co-ordinating Association.

Mr. Hardy said that the object of his lecture was " to sketch the present day merchant ship type family to show how it has come into being as a result of the evolutionary trends since the turn of the century and to point out how new cargoes, changing demands for existing cargoes and developments in technology are likely to affect developments in the future."

Dealing first with passenger ships, he said: " In its modern conception this type is being built to carry less cargo and more passengers. Increasing demands on the scores respectively of air conditioning and of extra space needed for crew, will tend in the near future to cut down the space used for dining saloons gainfully employed but for a few hours out of the 24, will harden the move towards cafeterias and self-feeding arrangements and pay-as-you-go methods; it will also encourage investigation into the possibilities of using pre-cooked foods, particularly on routes such as the North Atlantic. Space and weight will be saved by the elimination of heavy lifeboats and davits and their substitution by inflatable rubber dinghies.

" Alterations in the regulations for the measurement of net tonnage will encourage the use of more compact machinery for power delivered and the tendency to place powerful machinery aft will undoubtedly be maintained."

Turning to cargo ships. Mr. Hardy said that the tendency to-day is not so much the elimination of tramp operation, as change in the instrument of operation. Many people see the demise of the 10,000 ton 11½-knot coal, grain and general cargo, shelter deck, single screw, steam or motorship, with machinery amidships, and its gradual merging into the slower class of non-specialised cargo liner. The urgency of demand for such specialist cargoes as bauxite, sugar and ore, and the very slow rate of loading and discharge which attend their carriage by shelter deck 'tween-deck ships, is encouraging the production of specialised ships.

" The number of specialist ore carriers," he went on, " whose ownership a quarter of a century ago was confined to Sweden, Germany and the Great Lakes, has now spread, and there is a record number operating under the British flag. They range in size from 20,000 tons down to 8,000 tons. These ships are intended to deal with the products of the new ore fields which are being opened."

" The carriage of bauxite by ordinary shelter deck 'tween-deck ships is on a diminishing scale. Here again vast developments in Central America, coupled with the fact that bauxite loading plants are situated far up rivers whose navigation is exceedingly difficult, has called for the construction of a group of medium sized carriers with machinery aft, with special air-conditioning and an arrangement whereby dust can be excluded from the engine room. Incidentally, these ships vindicate the idea that it is possible to operate a ship of ocean-going size with the navigating bridge and all accommodation and machinery at the aft end of the ship. Here, too, we are not likely to see the immediate demise of the 10,000 tonner with machinery amidship. She, too, has grown to gradual perfection from the 7½-knot 3-island ship with auxiliary sail of 50 years ago and she still fulfils a useful function. Casual tonnage is still part of the world's transportation scheme, even though it may have changed its size, shape and purpose."

After outlining the changes which are coming about in refrigerator tonnage, the lecturer discussed the tanker and observed that " there does not seem to be any marked tendency towards stopping the upwards trend of size. A figure of 60,000 tons deadweight is currently quoted as the biggest " monster " tanker now under construction in a Japanese shipyard for American ownership. The 16,000 tonner, which was a monster tanker prior to the war, is now an average tanker and the 9,600 tonner, which was a standard utility type, is now considered as a small unit. The combination of ore and oil carrier still seems to find favour, though it is not always possible to find return cargoes."

A diagram was distributed to illustrate Mr. Hardy's description of the evolution of the merchant ship from the beginning of the present century. This showed the eras through which merchant shipping has passed and the way in which technical changes and other features have come into being. Amplifying the diagram, Mr. Hardy said " there is a general feeling to-day that for all except bulk cargoes, the hatch is obsolescent and that cargo will be loaded through side doors. Container traffic, with trucks and trailers, visions an entirely new method of through transport, with loading at the factory and unloading at destination. This is a generalisation which obviously only applies to certain kinds of cargoes consistent with the development of modern packaging. To harness to reality the many new forms of water transport which are available and the many different ways in which cargo can be delivered to the ship's side for onward transport, is indeed one of the most difficult tasks with which the designer of modern cargo ships—intended for the general as contrasted with the bulk trades—is concerned."

Continuing, Mr. Hardy said that he had found that a body of opinion in the U.S.A. was " completely at one with the idea of the truck and trailer principle of transport, an idea which, in fact, they have used for a number of years. They have also trended away from the unorthodox, in such ships as Seatrains, which carry loaded freight cars on coastwise voyages of many hundreds of miles; and they do not object to a specialist design of ship operating on the Great Lakes, in which the " engine room " is a separate, detachable, pusher unit, fitting in a V slot in the stern of the cargo portion. In cargo handling, recapitulating the lessons of amphibious warfare, the Americans to-day think in terms of " unitised " cargo-handling, with ships carrying " unitised " rubber containers, watertight and strung together like hot dogs on a double chain, lowered into the ship's hold by a winch equipped with ratchets, the teeth of which grip the chain. The last container is attached to the ratcheted winch, hauled out of the hold and moved over the side into the water. Once in the water, the string of buoyant containers can be towed to shore by an amphibious tractor. The train of containers can be towed up on the beach, quickly opened and collapsed and turned into the ship for return shipment, without protection or crating."

" This interesting device is not as far fetched as it seems. It would appear to be a solution to the problem of handling cargoes expeditiously in open roadsteads, where economics or the time factor do not necessarily permit of the construction of a proper harbour. Another device, British in origin, has been devised as a complete harbour with sheds, barges, etc., which can be carried in the hold of a large ship with machinery aft, dropped over the side and assembled in place."

Concluding, the lecturer said that, while such developments are naturally and desirably evolutionary rather than revolutionary, world-wide technological developments do not permit of any complacency in shipping or shipbuilding, or of any clinging to the old idea that " we've never done that before . . . and, in any case, it won't work."

New Chief Engineer for Port of Dublin.

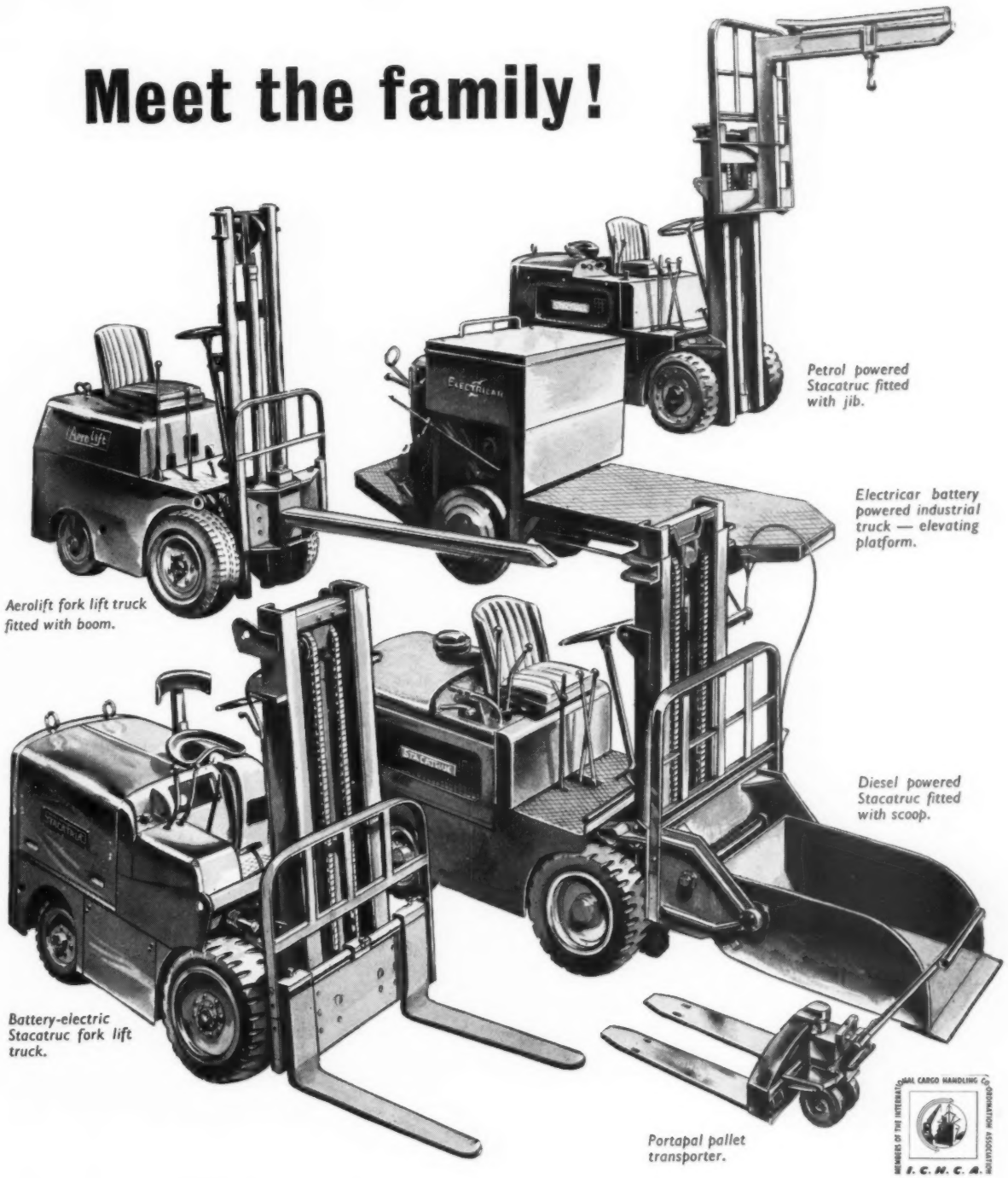
Mr. J. C. Buckley, vice-president of the Institute of Civil Engineers of Ireland, has been appointed chief engineer to the Port of Dublin in succession to the late Mr. F. W. Bond.

After qualifying in 1922, Mr. Buckley was on the engineering staff of the Shannon power development scheme from 1925 to 1928, and then went to Kenya as assistant engineer to the public works department in Mombasa. He returned to Ireland in 1931, and became temporary assistant engineer to Dublin County Council, and later held engineering appointments in Limerick and other parts of the country.

Mr. Buckley joined the engineering staff of the Dublin Port and Docks Board in 1935, and was made assistant engineer in 1936. He was appointed principal assistant to Mr. Bond in 1945.

Work has begun on the reconditioning of the ancient port of Richborough, Kent, to convert it into a Continental car ferry terminal, capable of accommodating vessels of up to 2,000 tons gross.

Meet the family!



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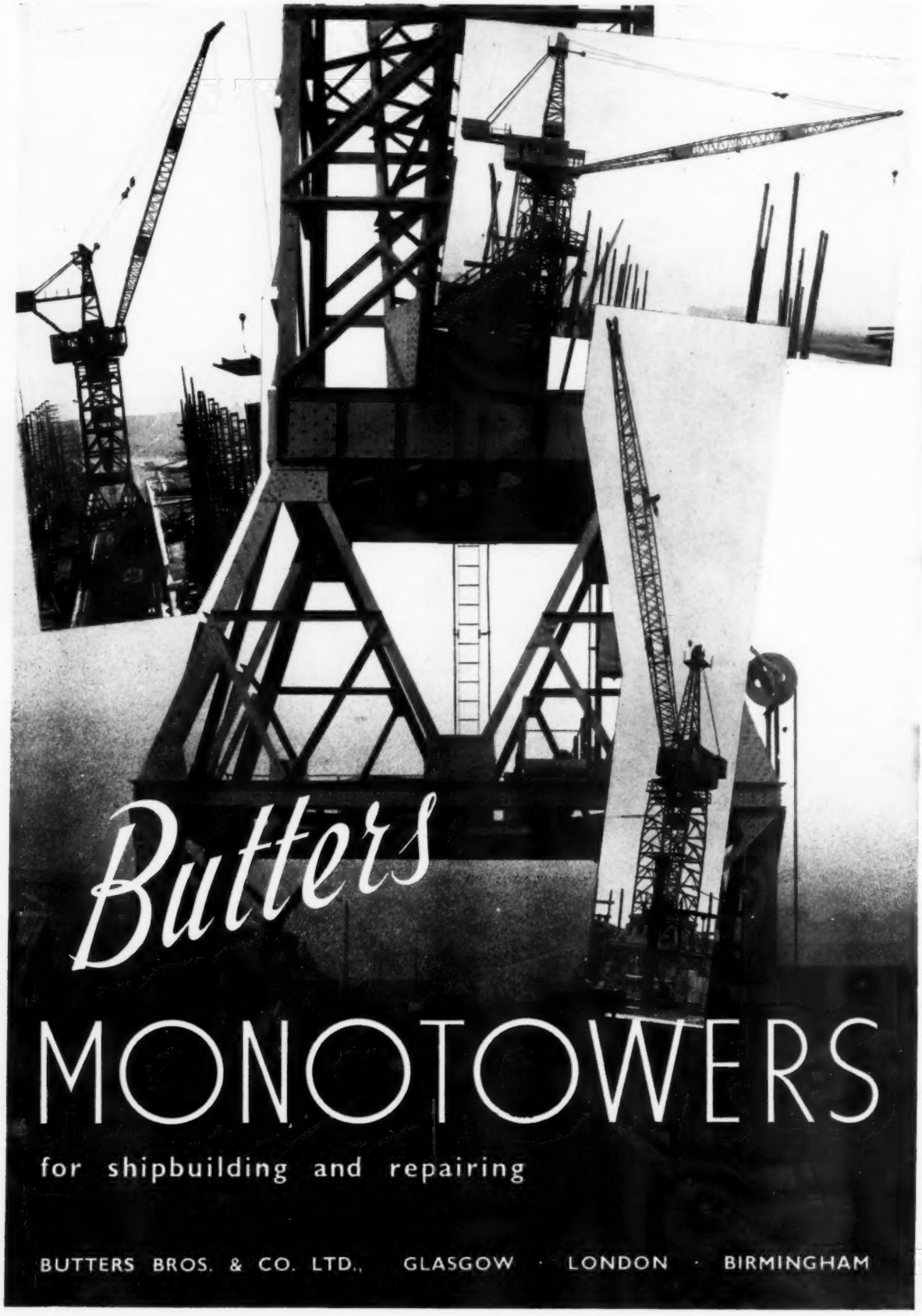
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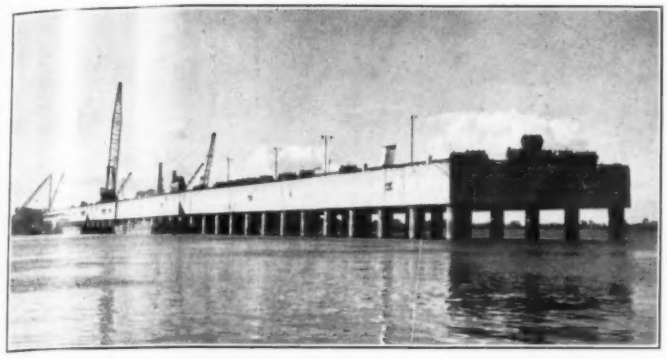
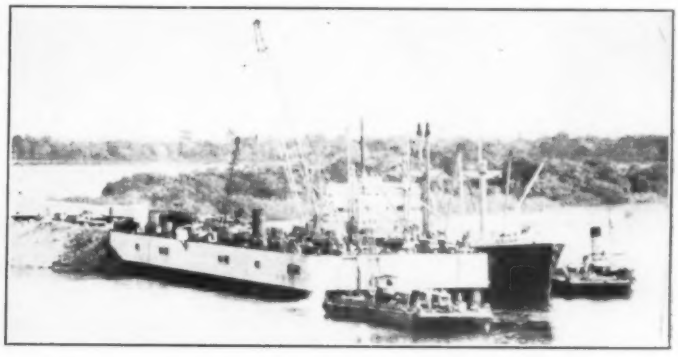
1. *Orinoco Mining Company's new ore and cargo handling dock on the Orinoco River, Venezuela. Composed of 3 units, this DeLong dock is 1,130 ft. long, 82 ft. wide, and 15 ft. deep.*

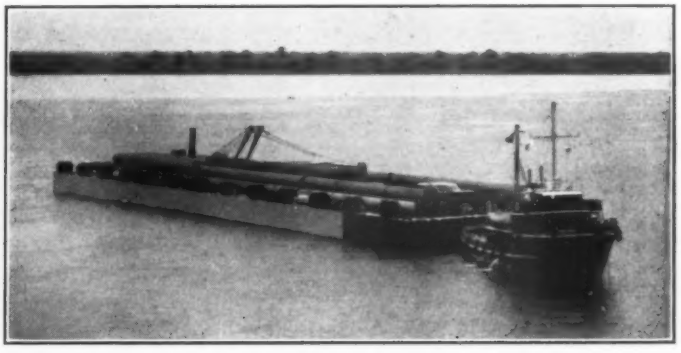


2. *A week after arrival at Orinoco River site, first dock section 376 ft. long berths ship, and unloading begins. Two additional units make this pier 1,130 ft. long.*



DeLong airjack transforms sea going dock-barge into ore and cargo pier !

3. *Dock sections were economically fabricated at an Orange, Texas yard and launched for towing to pier site.*



4. *Loaded dock section arriving at site on Orinoco River, Venezuela, after being towed across 3,000 miles of ocean. Dock carried caissons crane, Airjacks, compressors, generators, and all other installation gear.*

Cuts time, costs ! Field work is practically eliminated in dock construction, due to the development of the patented DeLong Airjack. This new technique of dock construction speeds installation, cuts cost.

The DeLong Airjacks, which are the key to the whole transformation of barge to pier, enable the dock to 'climb' the steel columns, or caissons, to required elevation. After the self-lifting operation, caissons are driven to refusal for permanent installations. Caissons are welded to deck and cut off flush ; then filled with concrete or sand and tops closed with welded cover plate.

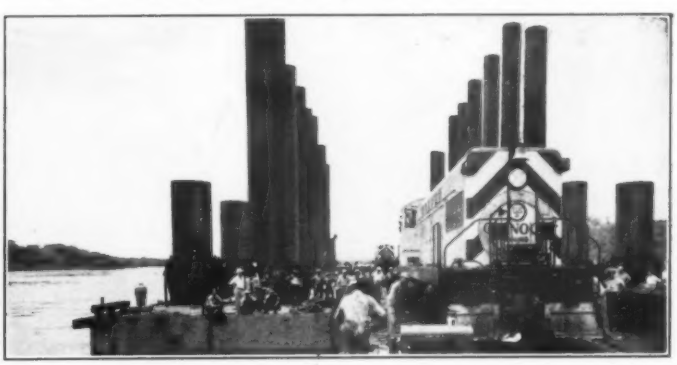
More than ½ million sq. ft. of the DeLong type of pier are in use or under construction in diversified locations that range from the Arctic to South America.

The DeLong Airjack can cut time and costs in the construction of offshore oil well drilling platforms, portable and permanent piers, and many other types of installations. A DeLong dock can be erected and, after having served its purpose, jacked back to water level and towed to a new location.

DeLong Engineering & Construction Co.
29 BROADWAY, NEW YORK 6, NEW YORK
Phone : HAnover 2-1275 Cable : DELONGDOCK

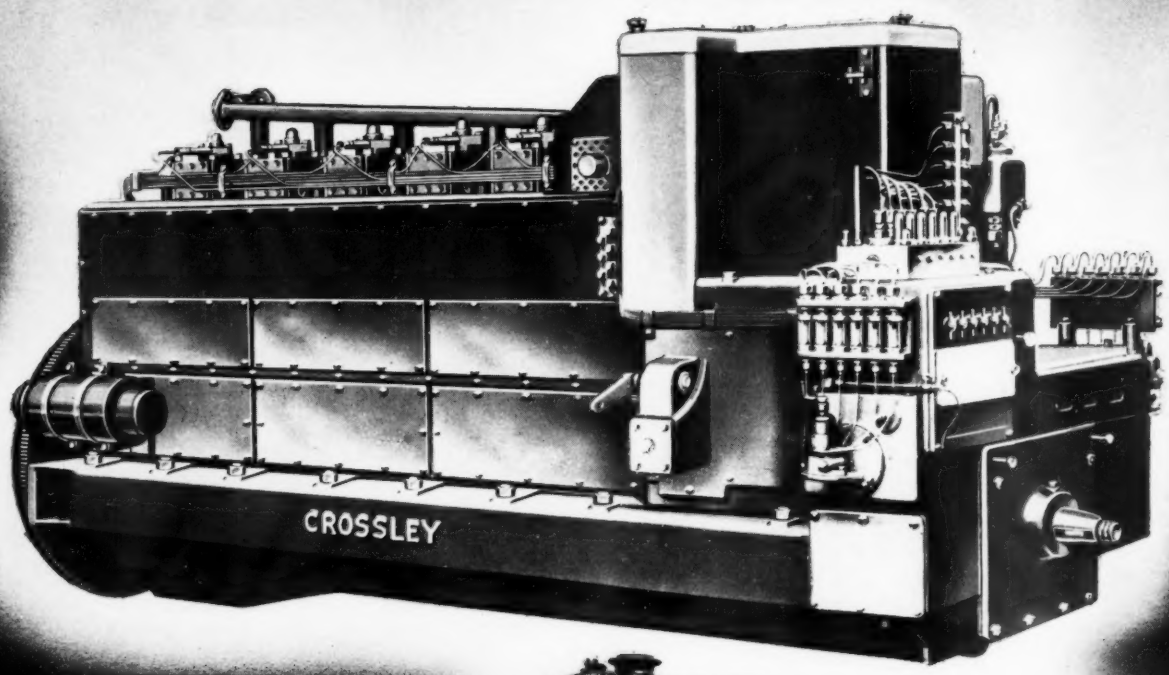
5. *Crane placing 6 ft. diam., 100 ft. long steel caissons in wells fitted with Airjacks. Crane, Airjacks and other equipment were later transferred to second and third sections for erection purposes.*

6. *Caissons held in position by Airjacks until dock barge is jockeyed into final position. Caissons are then dropped to river bottom and DeLong Airjacks lift dock to final elevation. Control is so precise, height of dock can be regulated to 1/42 of an inch.*



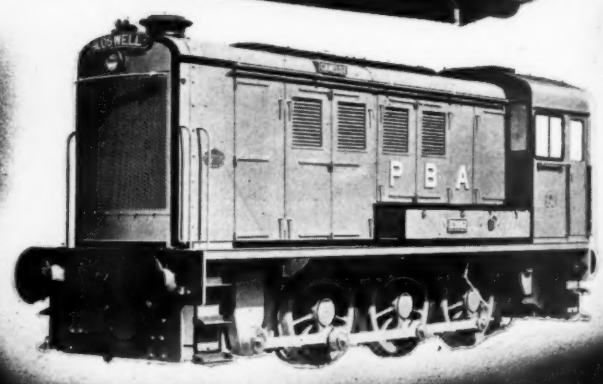
CROSSLEY DIESEL ENGINES

are fitted in the Port of Bristol Authority's Shunting Locomotives



The illustration shows one of four Crossley six-cylinder Two-cycle, Exhaust Pulse Pressure charged Diesel engines, providing power for the shunting locomotives in service with the Port of Bristol Authority.
The engines have a rating of 330 B.H.P. at 750 R.P.M.

Crossley Engines are built in four-stroke and two-stroke types, Vertical and Horizontal, from 10 to 3,000 B.H.P. for Industrial, Electric, Marine and Rail Traction Duty.



With acknowledgments to The Port of Bristol Authority and to Messrs. Hudswell Clarke & Co. Ltd., Leeds.

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C 364

Shunting Locomotives for Dock Work

Maintenance and Running Considerations of Straight Diesel Engines

By A. O. HELPS, A.M.I.Mech.E., M.I.Struc.E. and R. H. NICHOLSON, A.M.I.Mech.E., A.M.I.Loco.E.
Engineer-in-Chief's Department, Port of Bristol Authority.

IT will be appreciated from the perusal of various articles published in this journal and other technical periodicals that the use of the diesel shunting locomotive in docks and other industrial concerns, has increased considerably during the last few years, and various articles have appeared indicating the relative advantages and economics of their use under given circumstances. Very little information has been published with regard to the servicing and maintenance of this type of shunting locomotive and there is no doubt that under favourable conditions economic advantage can be obtained from diesel locomotives providing that regular servicing from the outset is carefully planned and supervised with proper understanding.

The writers have been operating diesel locomotives for some time and feel that the system they have evolved might serve as a guide to other authorities either using or considering the employment of this relatively new method of traction.

In order to ensure years of satisfactory and economical operation, strict attention should be paid to the following vital factors.

1. Design features of the locomotive and prime mover.

The initial selection of the locomotive (and prime mover) should be based on a predetermined survey of the type of work for which it is required. Three types of transmission are now commonly used—mechanical, electrical and hydraulic—and each has its own peculiar merits and disadvantages.

For medium-powered shunting units, a good case can be advanced for the selection of any of these drives. For a given rating, mechanical transmission can always score on lowest initial cost, whilst electrical and hydraulic drives are preferable for operational simplicity and possess more favourable torque characteristics. From a maintenance view point, mechanical/hydraulic locomotives can be serviced almost completely by one grade of artisan staff which should result in less tendency of neglect.

When considering designs of diesel shunters, strict attention must always be paid to maximum accessibility of all components. This feature unfortunately does not always receive the attention it deserves from locomotive manufacturers, whose inability to conceive the layout from the maintenance man's viewpoint can often result in hours of extra work and a corresponding decrease in availability. Maximum availability and low maintenance costs can only be achieved by a locomotive whose design is fundamentally correct from all aspects. For this reason, good liaison between the manufacturer and buyer is essential both at the design and erection stages of the locomotive.

One important point which should always be watched at design stage, is the suitability of the proposed wheelbase to the buyers' rail tracks and their limiting curves. To ensure trouble-free running and avoid loss of availability through hot axle bearings and frequent lifting, both guides and axlebox faces should be fitted with manganese steel liners which almost entirely eliminate wear and give quieter and more efficient operation. If plain axleboxes are specified, care should be taken to ensure that they have adequate bearing surfaces, preferably fed by forced lubrication. The present tendency would indicate that the latter is being gradually displaced by roller bearing axleboxes, which afford longer life and greatly reduced maintenance. Coupling rods should preferably be fitted with floating bushes located within renewable steel housings. These maintain good wearing characteristics and facilitate renewals.

Strict attention should also be paid to the selection of the prime mover. It is primarily essential that the continuous rating of the engine should be capable of dealing with the maximum required train load to be hauled, and for this reason, it is always wiser to err on the conservative side when specifying the rating. A diesel engine subjected to fairly continuous overloads remains anything but trouble free, and the practice of coupling on a few extra wagons additional to the specified maximum load is by no means uncommon, if unofficial. The next point to decide is whether the engine under consideration has a good past record, especially with regard to traction duties. It is felt that engine makers should realise that there is and will be a great demand for a prime-mover of reliable rating and construction for fitting to industrial locomotives (of 200-300 B.H.P. rating) and it is time that they gave very serious consideration to the design of a traction type prime mover designed from the outset as such, and not merely an adaptation of even well tried marine or land installation type engines. Due to space and weight limitations which are usually present in the standard shunting locomotive, the traction engine is circumstantially small in size, resulting in a high power/weight ratio. This means a relatively high B.M.E.P. and piston speed, a combination of which is certainly not conducive to long cylinder life so far as wear is concerned.

Fuel and oil consumption characteristics and general design should also be investigated, as well as the lifting provision made.

For maximum availability and trouble free performance the right engine for the locomotive and its specified duty is absolutely essential.

2. Training and duties of drivers and maintenance staff.

The control system of most diesel shunters is usually so simple, that a man of average intelligence can be transferred from a steam locomotive and taught to drive within a few hours. Many older men, however, possess a definite steam bias, and for this reason it is preferable to select younger staff for diesel drivers who are more willing and able to adapt themselves to the new technique. Good availability and low maintenance can only be achieved by intelligent handling of the locomotive when in traffic, and for this reason, every assistance should be given to the driver to ensure him gaining a thorough working knowledge of his locomotive. Simply worded, but detailed instructions, both on driving technique and daily preparation and servicing duties, should be issued to each man, and every attempt made to ensure that he handles the locomotive *only in the correct manner* from the start. A thoroughly trained and keen driver is a guarantee for the locomotive in itself, and it is most important that one man (or crew) should be permanently allocated to one locomotive, if this can be practically achieved. For similar reasons, servicing and maintenance duties should be shared between as few a number of artisan staff as possible. Opportunity should also be made for the senior fitter in charge of maintenance to visit the works manufacturing specialist items such as the prime mover, gearbox, fluid coupling, etc., in order to gain as much information as possible before the locomotive's arrival. Whenever possible, the senior maintenance fitter should have received a diesel training, with subsequent oil engine experience as a journeyman.

3. Maintenance aspects conducive to high availability (with particular reference to the Prime Mover).

The diesel locomotive should essentially be maintained according to a carefully prepared servicing schedule. This is the only way to avoid potential failures in traffic and consequent high operating costs. Most firms manufacturing component parts for the locomotive, publish comprehensive information giving their recommendations as to how long a period should elapse between servicings or adjustments or renewals, but it must be remembered that working and load conditions vary from user to user, and for this reason makers recommendations should be used only as a yard-stick and not applied too literally. Experience of individual site conditions is the only true way of formulating an economical but thorough schedule and this will always take some time to acquire. It is always safest to commence with the servicing

Shunting Locomotives for Dock Work—continued

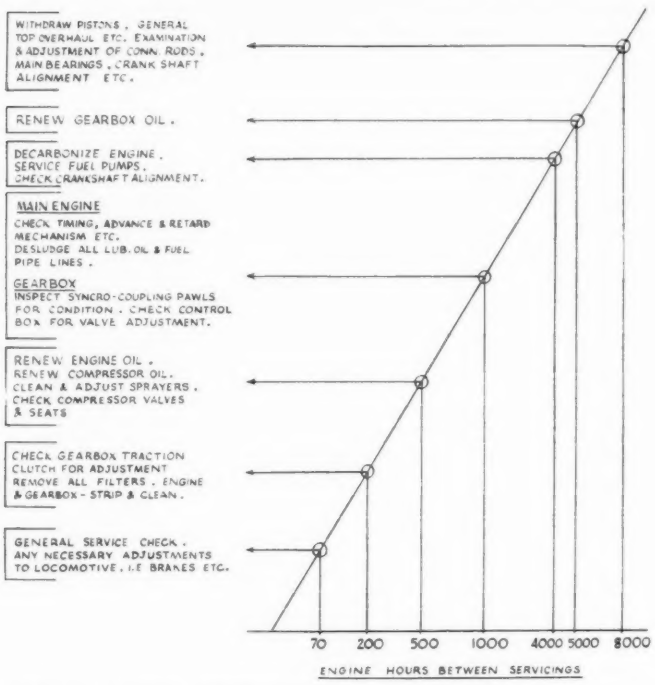

WITHDRAW PISTONS . GENERAL TOP OVERHAUL ETC. EXAMINATION & ADJUSTMENT OF CONN. RODS, MAIN BEARINGS, CRANK SHAFT ALIGNMENT ETC.
RENEW GEARBOX OIL.
DECARBONIZE ENGINE. SERVICE FUEL PUMPS. CHECK CRANKSHAFT ALIGNMENT.
MAIN ENGINE
CHECK TIMING, ADVANCE & RETARD MECHANISM ETC. DESLUDGE ALL LUB. OIL & FUEL PIPE LINES.
GEARBOX
INSPECT SYNCRO-COUPLING PAWLS FOR CONDITION. CHECK CONTROL BOX FOR VALVE ADJUSTMENT.
RENEW ENGINE OIL. RENEW COMPRESSOR OIL. CLEAN & ADJUST SPRAYERS. CHECK COMPRESSOR VALVES & SEATS
CHECK GEARBOX TRACTION CLUTCH FOR ADJUSTMENT REMOVE ALL FILTERS. ENGINE & GEARBOX - STRIP & CLEAN.
GENERAL SERVICE CHECK. ANY NECESSARY ADJUSTMENTS TO LOCOMOTIVE. I.E BRAKES ETC.
70 200 500 1000 4000 5000 8000
ENGINE HOURS BETWEEN SERVICINGS

Fig. 1. Typical Maintenance Schedule for 200 B.H.P. diesel mechanical loco fitted with 4 cycle engine.

periods set down by the makers, but these may be extended from time to time according to conditions and experience until an economical deadline is reached.

The component requiring most careful attention is the prime mover, and to guarantee a high availability its maintenance and condition should be of the highest order. One of the most important factors upon which a long and trouble free engine life depends is the initial selection and subsequent control of the lubricant, which in addition to its essential function of reducing friction and wear, must also act as a cooler to remove heat from the bearings and provide good sealing characteristics in order to maintain compression and reduce the blow-by of gases past the pistons. Among certain other important characteristics (on which the scope of this paper precludes further comment), the lubricant should also possess low carbon forming tendencies and an ability to prevent or retard formations of insoluble deposits in the crankcase and of lacquer or carbonaceous material on the pistons and cylinders. In selecting an oil, the most important thing to decide, after the most suitable viscosity has been determined, is whether a straight mineral or detergent oil is preferable. This depends to a great extent on the design characteristics and rating of the individual engine. Factors such as B.M.E.P., piston ring temperature, engine size and piston speed and quality of fuel oil largely determine the extent of improvement that detergent oils will give, and in view of the higher ratings usually experienced with traction type engines, these oils now find much application. In some engines, however, usually designed with lower ratings, satisfactory lubrication can be obtained from straight mineral oils and detergent oils show little advantage. Other engines can be lubricated with straight mineral oils without any trouble whatsoever, but can be run for considerably longer periods between overhauls and at lower operating costs on detergent oils. Whilst the adoption of detergent oils may show a definite reduction in operating costs through reduction of wear and general engine cleanliness, it does not follow that oil costs will be reduced in proportion. Detergent oils are initially more expensive and as they hold in suspension a large amount of matter that would otherwise form deposits in the engine, they are inevitably rendered unserviceable after use. In general, however, the increased expenditure with detergent oils can usually be weighed against the savings effected through increased engine efficiency and reduced maintenance costs.

The importance of correct engine lubrication cannot be over estimated, and when deciding what oil to use, its initial cost should never be the deciding factor. A little extra money spent on a good (but correct) oil will prove negligible compared to the cost of maintaining a troublesome engine brought about by the use of an inferior lubricant.

Strict attention should be paid to the maximum period allowed between oil changes, which can only be determined by individual working conditions and experience. The engine maker's recommendation should certainly not be disregarded, but the economical life of an oil charge depends entirely on its condition. For this reason, samples of sump oil should be analysed from time to time and the chemist's decision taken as final as to when the oil should be changed, based mainly on the percentage of insoluble matter present. By having this done at the commencement of the locomotive's life, a satisfactory period between oil changes can be determined and subsequently applied. It should be noted that most of the proprietary oil companies are very helpful in this respect and will analyse oil samples from time to time, giving full details of all that is required. An oil analysis can be most indicative of the engine's mechanical condition, as bad combustion or piston blow-by immediately reflects on the balance between viscosity, distillation and insoluble concentrations, present in the oil. As a rough guide, a detergent oil should never be allowed continued use when the insolubles exceed 10 per cent., and in the case of ordinary mineral oil, 5 per cent.

Similarly, maximum allowable periods between decarbonisation and piston withdrawals can be arrived at. It is extremely important that the fuel injection system is maintained in perfect condition. When the engine is running on normal load, it is essential that this must be equally distributed over the range of cylinders, which means that each injector must deliver an equal proportion of fuel. The load taken by each cylinder is reflected proportionally by its exhaust temperature, so that when the engine is in balance, there should be no appreciable fluctuation between the exhaust temperatures of each cylinder. Exhaust temperature readings should be checked frequently (when the engine is running under normal load) and if any one (or more) is found to fluctuate above or below the mean, the cause should be immediately investigated and the trouble rectified. For this reason it

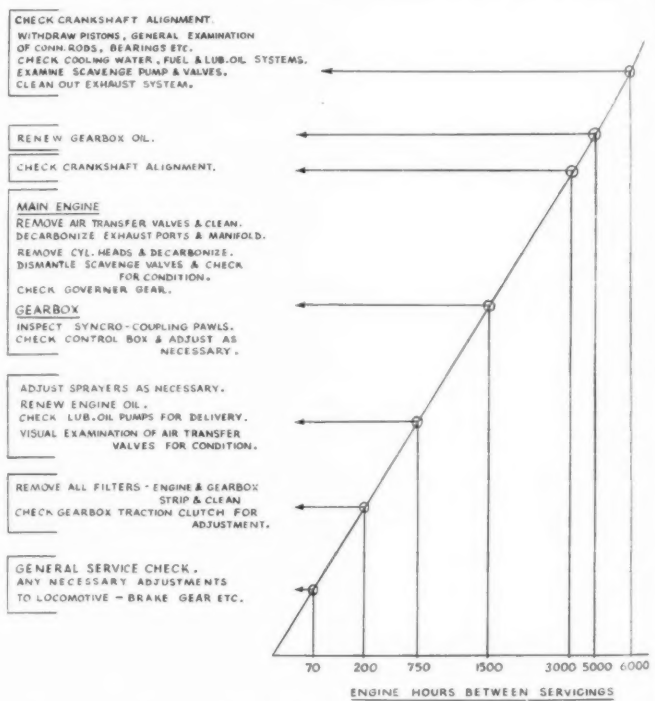

CHECK CRANKSHAFT ALIGNMENT. WITHDRAW PISTONS, GENERAL EXAMINATION OF CONN. RODS, BEARINGS ETC. CHECK COOLING WATER, FUEL & LUB. OIL SYSTEMS. EXAMINE SCAVENGE PUMP & VALVES. CLEAN OUT EXHAUST SYSTEM.
RENEW GEARBOX OIL.
CHECK CRANKSHAFT ALIGNMENT.
MAIN ENGINE
REMOVE AIR TRANSFER VALVES & CLEAN. DECARBONIZE EXHAUST PORTS & MANIFOLD.
REMOVE CYL. HEADS & DECARBONIZE. DISMANTLE SCAVENGE VALVES & CHECK FOR CONDITION.
CHECK GOVERNER GEAR.
GEARBOX
INSPECT SYNCRO-COUPLING PAWLS. CHECK CONTROL BOX & ADJUST AS NECESSARY.
ADJUST SPRAYERS AS NECESSARY.
RENEW ENGINE OIL. CHECK LUB. OIL PUMPS FOR DELIVERY.
VISUAL EXAMINATION OF AIR TRANSFER VALVES FOR CONDITION.
REMOVE ALL FILTERS - ENGINE & GEARBOX STRIP & CLEAN
CHECK GEARBOX TRACTION CLUTCH FOR ADJUSTMENT.
GENERAL SERVICE CHECK. ANY NECESSARY ADJUSTMENTS TO LOCOMOTIVE - BRAKE GEAR ETC.
70 200 750 1500 3000 5000 6000
ENGINE HOURS BETWEEN SERVICINGS

Fig. 2. Typical Maintenance Schedule for 300 B.H.P. diesel mechanical loco fitted with 2 cycle engine.

Shunting Locomotives for Dock Work—continued

is extremely important that each cylinder should have its own exhaust thermometer. This can be done by tapping the manifold and fitting direct reading thermometers, but the most satisfactory method is to have a set of remote reading thermometers positioned somewhere near the control panel in the driver's cab, with suitable couples returning to the exhaust manifold. An engine can be thrown out of balance due to unsatisfactory mechanical condition of the sprayers or fuel pump. For this reason, sprayers should be removed and cleaned at frequent intervals, say every 500 hours and tested for delivery and atomisation using a standard hand pump. It is also considered advisable to replace all sprayers, say when the engine is stopped for decarbonizing, with a works' reconditioned set. The old ones should then be returned to the makers for servicing. Similarly when the engine is stopped for a main overhaul, the fuel pump should be sent to the makers' works for testing (and if found necessary, resetting). In this way, maximum injection efficiency can be obtained. Particular attention should be paid to the cleanliness of the fuel, and all filters in the fuel line service tank should be removed and cleaned once a week. Adequate fuel storage facilities must also be provided at the locomotive sheds and care taken to drain off sludge and water each time the tank is emptied. A filter should be provided between storage tank and delivery connection to the locomotive.

Two typical maintenance schedules are shown, Figs. 1 and 2, one for a 200 B.H.P., 4-stroke engined locomotive, and the other for a 300 B.H.P. 2-stroke engined unit. It should be appreciated that these are not intended to cover every range of similar units, as times between the different servicings fluctuate to a degree with the type of duty performed by the individual locomotive. This is also influenced by the grade of engine lubricant used.

These schedules indicate that in each case, checking of the crankshaft alignment falls due on two occasions within their range. In judging the state of an engine, the crankshaft alignment should be taken as the most important single indication, and it should

DAILY WORKING OF DIESEL LOCOMOTIVES

LEGEND — (RED) IN TRAFFIC; (BLUE) SPARE; (GREEN) IN WORKSHOPS; (YELLOW) WS WEEKLY SERVICING

DATE	200 BHP LOCOS			300 BHP LOCOS				REMARKS
AUGUST - 1953	D2001	D2002	D2003	D3001	D3002	D3013	D3004	
SATURDAY 1ST								
SUNDAY 2ND	•		•	•	•	•	•	
MONDAY 3RD		WS						
TUESDAY 4TH					WS			
WEDNESDAY 5TH	WS			•				
SUNDAY 30TH	•	•	•	•	•	•	•	
MONDAY 31ST				WS				
AVAILABILITY %	90	93	90	90	90	93	87	
MAINTENANCE %	10	7	10	10	10	7	13	

NB – LOCO COUNTED AS AVAILABLE IF SPARE. MAINTENANCE INCLUDES ANY SERVICING IF LOCO NOT IN OR AVAILABLE FOR TRAFFIC THAT DAY

FIG. 3

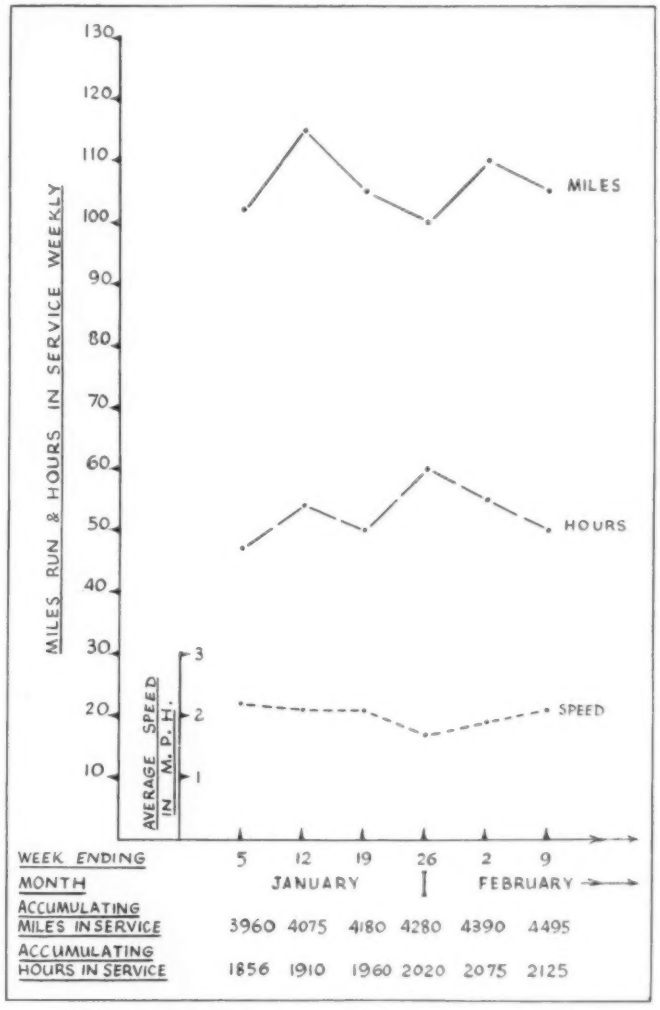

MILES RUN & HOURS IN SERVICE WEEKLY
AVERAGE SPEED IN M.P.H.
MILES
HOURS
SPEED
WEEK ENDING 5 12 19 26 2 9
MONTH JANUARY FEBRUARY
ACCUMULATING MILES IN SERVICE 3960 4075 4180 4280 4390 4495
ACCUMULATING HOURS IN SERVICE 1856 1910 1960 2020 2075 2125

Fig. 4. Running Log for diesel loco No. 2—Year 1952.

largely determine whether or not an engine should receive extensive overhaul. The permissible crankshaft deflection depends entirely on the type and size of prime mover, and the prescribed limits are best obtained from the manufacturers.

4. Availability and Maintenance Recording.

A maintenance system, however good, falls down if it is not applied at exactly the right time. For this reason, an efficient means of recording the locomotive's life history is essential. Such a system can be applied quite simply, and if the necessary records are compiled at frequent intervals, only a minimum of time need be spent in keeping it going.

For interest, the system followed by the writers is described below:

The daily availability of each locomotive is recorded on a special log sheet made out to cover each calendar month (see Fig. 3). From the legend shown, a certain colour indicates its position from day to day. If it is shown red, it is in traffic; blue, not required; yellow, being serviced; green, in workshops for repairs. At the end of the month, the performance of each locomotive is analysed and its percentage availability recorded.

As the details of Fig. 3 cannot be shown coloured, the legend details have been hatched in differently for each state.

The gross mileage and engine hours of each locomotive is recorded weekly and the individual mileage, engine hours and average running speed for each particular week is graphed (Fig. 4). This information is vital as the accumulative engine hours are required from time to time in order to decide when servicing and overhaul periods are due. The graphical characteristics of weekly

Shunting Locomotives for Dock Work—continued

miles, hours and speed, make interesting details of the locomotives' performance.

A separate file is kept for each locomotive, containing its particular servicing schedule and recording sheets on which servicing details are compiled. In a corner of each sheet of the schedule a note is kept of the gross running hours when the locomotive is due for that particular servicing or overhaul. When this has been done, the figure is altered, ready for the next time. On the record sheets details of all scheduled servicing are shown in blue, but if the locomotive has actually failed in traffic, the resulting repairs done are indicated in red ink.

The weekly time taken per locomotive to keep this system in operation is approximately 15 minutes.

5. Diesel engine ratings in terms of hauling power.

In order to prevent rapid engine wear through frequent overloading, it is essential to establish at the outset the maximum train capacity that the locomotive can safely haul, but up to its economic limit. For a given engine rating, the haulage capacity can vary considerably, as this is largely dependent on track layout

ENGINEER'S DEPARTMENT

LOADING SCALE FOR 200 B.H.P. DIESEL LOCOMOTIVE

CLASS OF TRAFFIC	MAX. No. OF TRUCKS THAT MAY BE HAULED	
	LADEN	EMPTY
GENERAL GOODS	36	60
CONCENTRATES	30	60
MEDIUM OIL TANKS	24	45
HEAVY OIL TANKS	18	40

LOADING SCALE FOR 300 B.H.P. DIESEL LOCOMOTIVE

CLASS OF TRAFFIC	MAX. No. OF TRUCKS THAT MAY BE HAULED	
	LADEN	EMPTY
GENERAL GOODS	60	90
CONCENTRATES	45	90
MEDIUM OIL TANKS 23½ TONS GROSS	35	60
HEAVY OIL TANKS 31 TONS GROSS	28	45

UNDER *NO* CIRCUMSTANCE SHOULD THE MAXIMUM NUMBER OF VEHICLES WHICH MAY CONSTITUTE A FULL LOAD BE EXCEEDED

FIG. 5

with its curves and gradients, and most important, its general condition. The design of the wagons in use must also be taken into account, as vehicles with grease axleboxes offer an exceedingly higher resistance than the more usual and now standard oil lubricated axleboxes. All data below is based on the writers' experience, so far as the usual standard of track found on docks estates and sidings is concerned, and forms the basis used when deciding the haulage capacity of all locomotives under their supervision.

The net haulage capacity of a locomotive (steam or diesel)

$$= \frac{TE}{R} - W \text{ Tons.}$$

Where TE = Tractive effort of locomotive in lbs.
R = Total starting resistance in lbs./ton.
W = Weight of locomotive in tons.

The tractive effort is always stated by the locomotive manufacturers, though it can be calculated quite simply. Total resistance can only be calculated on conditions at site, taking into consideration the state of the track and the types of vehicle in use, though a typical case for the average siding is given below:

It should be noted that the writers always use a standard starting resistance for typical dockyard track layout of:

18 lbs./ton for oil lubricated wagon axle bearings.
27 lbs./tons for grease lubricated wagon axle bearings.

Considering the starting of a train of heavy oil tanks, half on a 300-ft. radius curve, half on straight and level track:

Tare weight of tank car—11 tons.
Gross weight of loaded tank car—31 tons.
Lubrication—oil axle boxes.

By Morrison formula:

$$\text{Curve resistance (whole train on curve)} = \frac{2240 \times (G + WB)}{2R} \times f$$

Where G = gauge of track in ft.
WB = wagon rigid wheelbase in ft.
R = radius of curve in ft.
f = coefficient of friction
= .27 (constant)

$$\therefore R_c = \frac{2240 \times (4.708 + 12)}{2 \times 300} \times .27$$

$$= 16.8 \text{ lbs./ton.}$$

(1) Curve resistance (whole train on curve) = 16.8 lbs./ton.
(2) Starting resistance (R_s) take at 18 lbs./ton for oil lubricated axleboxes.

Then total starting resistance, half on 300-ft. curve, half on straight and level track $= \frac{R_c}{2} + R_s$

$$\frac{16.8}{2} + 18 = 26.4 \text{ lbs./ton} - \text{Say } 26 \text{ lbs./ton.}$$

Thus a 300 B.H.P. diesel locomotive weighing 45 tons with a tractive effort (maximum) of 25,000 lbs. could start a train of:

$$\frac{25{,}000}{26} - 45 = 918 \text{ tons}$$

under these conditions.

As the gross weight per tank car is 31 tons, this represents a train of $\frac{918}{31} = 30$ tank cars.

For establishing loading tables for each differently rated locomotive working over the employing authority's tracks, the writers have adopted the "half train on a 300-ft. radius curve" basis as the standard total starting resistance in all calculations. This amounts to:

(1) 26 lbs./ton for oil lubricated wagon axle bearings.
(2) 34 lbs./ton for grease lubricated wagon axle bearings.

It should be noted that no gradients have to be contended with on the tracks concerned, but if this had to be included, the gross starting resistance would comprise:

$$\frac{R_c + R_s + R_g}{2}$$

$$\text{Where } R_g = \frac{\text{portion of train on gradient}}{\text{Total length of train}} \quad \frac{(2240)}{(\text{gradient})} \text{ lbs./ton}$$

i.e., If half the train was on and half off a 1 in 100 gradient, then

$$R_g = .5 \frac{(2240)}{(100)} = 11.2 \text{ lbs./ton.}$$

A loading scale in printed form for the different types of wagons handled is posted in the cab of each locomotive, and the driver made responsible to see that maximum allowable number of trucks are not exceeded. In this way overloading is reduced to a minimum.

No single factor can effect the satisfactory working of diesel locomotives more than overloading, and the engineering section of an undertaking should always have the final allocation of the locomotive loadings. In addition to the calculations given above, two typical loading schedules—one for a 200 B.H.P. and one for a 300 B.H.P. locomotive are given in Fig. 5. These again are based on "half train on and half off a 300-ft. curve."

Proposed Dublin-Preston Car Ferry.

The Irish seamen's and port workers' unions are negotiating with the Continental Car Ferry Company regarding the proposed service between Preston (Lancashire) and Dublin. The Dublin Port and Docks Board have given permission for the building of a ramp at Alexandra wharf and work is to start when the unions have settled details as to conditions of operation of the service. It is hoped to arrange accommodation for up to 120 cars.

New Type of Concrete Pile

The Stent-Sykes Pre-stressed Hollow Pile

In many situations and site conditions hollow concrete piles possess a number of advantages and the following considerations prompted Stent Precast Concrete Limited to develop and patent a new type of concrete pile, the Stent-Sykes Hollow Pile which is pre-stressed and sectional:

1. Hollow Piles can be made longer than solid Piles of the same weight. As the section modulus is almost double that of a solid prestressed Pile less steel is required, and the greatly reduced tension (lifting and handling), permits a considerable increase in working load.

2. Hollow Piles, being lighter for a given length, are easier to handle and cheaper to transport.

3. A sectional Pile is flexible and economical, as standard units can be quickly assembled to any required length, and therefore large stocks of each length of Pile are not required. If ground conditions are different from what were anticipated, it is very simple to make longer Piles with the standard units.

4. No unit weighing more than 1/3rd of a ton need be handled in the factory. As heavy equipment is not required it is economic to manufacture units adjacent to the principal Piling areas in any factory which is able to produce high quality concrete. Thus long hauls can be avoided and transport costs reduced with a consequent widening of the area in which Precast Piles are economical.

In order to obtain an indication of the overall economic advantages, figures have been taken out for a 50-ft. Solid Pile which must be at least a 14-in. x 14-in. section, and for a 50-ft. 16-in. x 16-in. Hollow Pile which, however, weighs only about the same as a 12-in. x 12-in. solid Pile.

The 14-in. x 14-in. Pile 1 : 1½ : 3 mix is generally assessed at 55 tons working load. The 16-in. x 16-in. Hollow Pile is of 6,000 lbs. concrete, and a factor of safety of three on the working load plus prestress allows a working load of over 75 tons.

On a cost per ton working load basis, at the Dagenham works the Hollow pile is 15 per cent. cheaper than a 14-in. Solid Pile.

If the piles were required at, say, Southampton, both piles having been made at Dagenham, the Hollow Pile would be 30 per cent. cheaper than the 14-in. Solid Pile, as transport charges further widen the margin.

If the pile units were cast at Southampton and assembled at the site this percentage would be further increased.

It should also be noted that fewer piles need to be driven so the driving costs are reduced.

Load Carrying Capacity.

Based on 6,000 lbs. concrete and a Factor of Safety of 3 on the Working load plus prestress.

16	wires	...	...	...	...	94 tons
20	,,	...	...	...	...	86 ,,
24	,,	...	...	...	...	79 ,,
28	,,	...	...	...	...	71 ,,
32	,,	...	...	...	...	64 ,,

Weight of Pile.

40-ft.	2.7 tons	Toe Unit weighs	360 lbs.
50-ft.	3.4 ,,	Inter. Unit weighs	720 lbs.
60-ft.	4.0 ,,	Underhead Unit weighs	790 lbs.
70-ft.	4.6 ,,	Head Unit weighs	620 lbs.

Maximum Allowable Lengths

No. of Wires 0.2" dia. 100-110 Ton	Resistance Moment lbs. ft.	Final Prestress lbs/sq.in.	Max. Cantilever	Method of suspension .3L	.2L	.2L	
16	21,100	483	15'	50'	70'		30'
20	26,300	604	17'	55'	80'		35'
24	31,750	726	19'	60'	85'		40'
28	36,906	846	20'6"	65'	95'		45'
32	42,200	966	22'	70'	100'		45'

Comparison of Handling Methods.

Although many reinforced concrete piles are pitched with a two point lift, the majority of stock piles are designed for one point pitching in order to cater for the worst site conditions. The extra steel thus incorporated increases the load carrying capacity to a certain extent. In prestressed Piles, however, an increase in resistance moment decreases the working load as is shown in the following table, in which a 70-ft. Pile is considered:

Method of Pitching	No. of Wires	Working load in Tons
Two slings at 1/5 point	16	94 tons
One sling at 1/3 point	32	64 tons

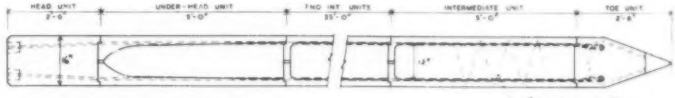
It will be seen that not only is the steel content doubled but nearly 50 per cent. more piles are required to take up the working load. There is, therefore, a great financial inducement to specify strict handling conditions for prestressed piles.

Results of Test Pile Driving.

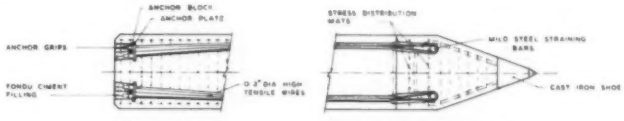
Test piles have been driven 50-ft. through made up ground and 16-ft. of grey clay into gravel and sand. Half-inch sets per ten blows were obtained with a 2½ ton monkey and a 4-ft. drop. The piles showed no signs of damage and would have certainly withstood severe driving. One pile was composed of intermediate units incorporating helical reinforcement, another pile contained no links, and in spite of the thin walls drove perfectly, all the test piles being in perfect condition at the completion of the driving.

General Description of Piles.

The test piles were 50-ft. long and 16-in. x 16-in. square, the core being 12-in. in diameter. The reinforcement was 4 No. high tensile steel cables each of 6 No. 0.2-in. diameter wires. There were ¼-in. helicals at 9-in. pitch generally, with links at 2-in. centres in the head and toe

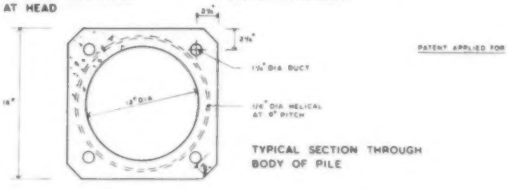


LONGITUDINAL SECTION THROUGH PILE



ENLARGED DETAIL SHOWING ANCHORAGE AT HEAD

ENLARGED DETAIL OF TOE UNIT SHOWING ANCHORAGE



TYPICAL SECTION THROUGH BODY OF PILE

In all Stent-Sykes piles there are 4 basic units: Head, Underhead, Intermediate and Toe. The drawing shows the general make-up of the pile.

Head Unit.

This is solid and well reinforced in the test piles with ¼-in. links at 2-in. centres. The anchorages are of a split type collet variety bearing on a mild steel anchor plate. The anchors finish 3-in. below the level of the head.

In production it is the intention to incorporate a hole 2-ft. from the head in order to secure the pile in the normal manner whilst driving.

Intermediate Unit.

The test pile reinforcement consisted of a ¼-in. diameter helical at 9-in. pitch. In one test pile this helical was omitted, and there was no reinforcement in the unit whatsoever. Spigot and socket joints aid the location of the units when offering together. Diaphragms stiffen the unit, and if the head is cut off, the uppermost unit can be filled with concrete, and mild steel bars cast in to tie with a capping beam. A duct in each corner is so located as to

New Type of Concrete Pile—continued

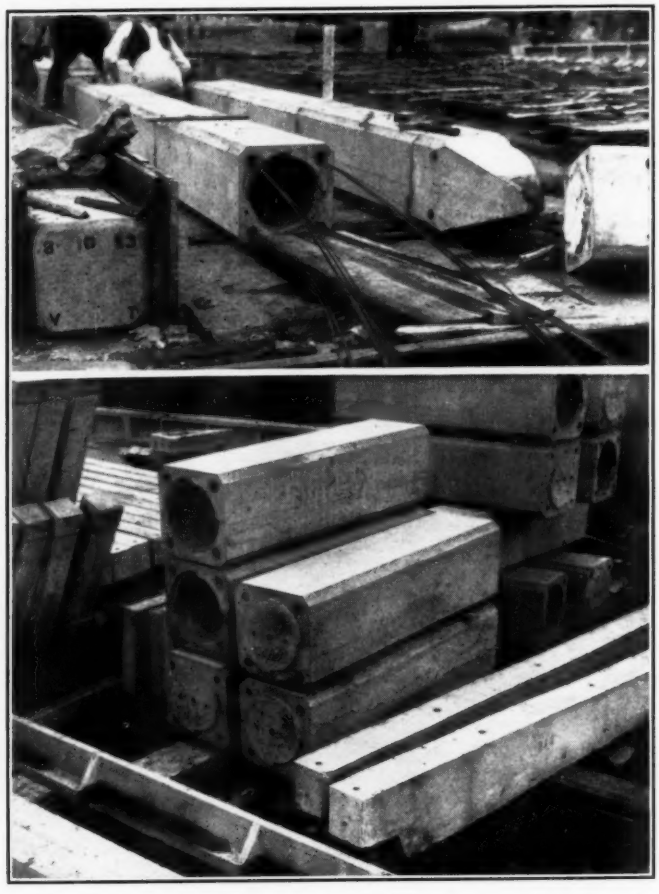
ensure 1½-in. minimum cover to the High tensile steel This could be increased to 2-in. if required.

Underhead Unit.

This is to outward appearance similar to the intermediate units, but the core is bullet shaped instead of cylindrical. An arched diaphragm transfers the stresses from the solid head to the fully cored intermediate units.

Toe Unit.

This serves as the fixed anchorage for the prestressing cables, which hairpin round a mild steel bar, as shown on the drawing. A cast iron shoe is incorporated, which has two loops of mild steel substituted for normal straps. These loops pass round the anchorage



Above: View of pile from toe end, showing cables being fed through ducts.
Below: Intermediate units, showing sockets and spigots.

bar, thus tying the shoe into the prestressed zone. Mild steel links are added at normal spacing, as in reinforced concrete. If shoes are not required they can be omitted, and a modified toe incorporated.

Jointing and Prestressing.

All units, except the toe, are put end to end on rollers, and the hairpin wires are passed through towards the head. The toe end of each duct is bell-mouthed to assist the threading of the wires. A waterproof cardboard ferrule is inserted at each joint around the cable.

It will be seen from the drawing that the ducts in the head units converge towards the top. A spacer device between the head and underhead units prevents the wires from bunching on the inside of the curve, which would prevent proper bonding when grouted.

The joints are successively mortared and offered together, the ferrule preventing the mortar from entering the ducts. The toe is then lined up and the hairpin passed through the square duct and secured with a mild steel round. The joint is then mortared and the toe pushed into position.

The anchor block is now threaded on to the cable, care being taken that the two ends of each hairpin are on opposite sides of the block. To prevent confusion the cables are cut with differences in length of about 3-in. so that each hairpin can be identified. The anchor block is then pushed home into the socket provided and four anchor grips are placed in position. By means of a light screw jack a uniform prestress of about four tons is applied to the pile which draws the joints together and ensures perfect contact between the individual units. The full prestress is applied the following day. At the present time the jack in use pulls up only two wires at a time, but a production jack is being designed which will enable the whole pile to be prestressed in two operations.

Immediately after stressing the surplus cable is cut off and the ducts are grouted from the head. The anchorage sockets are then filled with concrete and finished flush with the top of the pile. A wooden plug is cast in the socket insuring access to the screw threads in anchor block.

Extensions.

One of the principal problems in prestressed piling has been the extension of the pile, if it is found to be too short in the driving. In an attempt to overcome this problem provision has been made for the screwing of mild steel bars into the anchor blocks. The mild steel bar is thus effectively linked to the main prestressing cables and can take its full load without the normal necessity for splicing. These bars can be linked in the conventional manner and the pile lengthened as required.

Quicker Turn-Round at Australian Ports

Report of Stevedoring Industry Board

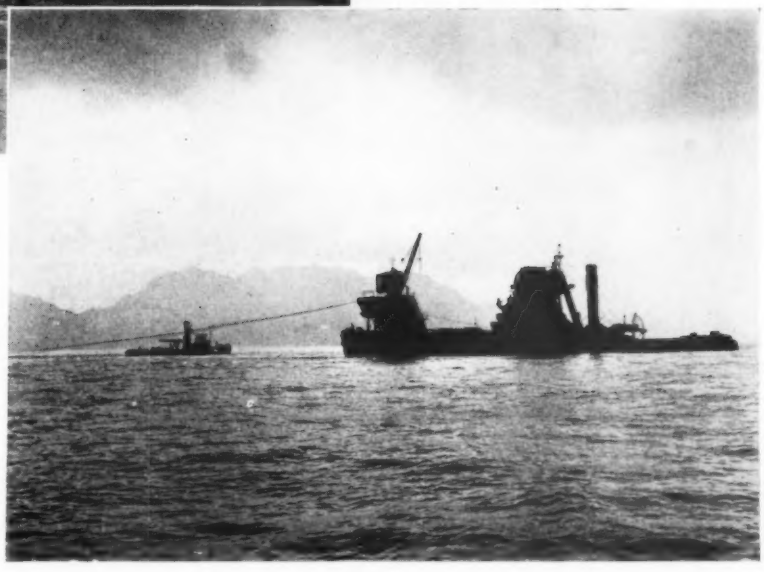
The annual report of the Australian Stevedoring Industry Board for the 12 months ended June 30th last, states that there was an improvement in the turn-round time of shipping at Australian ports during the year under review. The report shows that the proportion of working time lost through strikes and stoppages had fallen from 4.6 per cent. in the previous year to 3.1 per cent. At Sydney interstate vessels were spending an average of 5.5 days in port in the early part of the year, compared with 10.3 days in 1951. The time spent in port by overseas vessels had been reduced from 11.3 days to 7.6 days. The report adds: "In view of the criticism which is frequently levelled at the Waterside Workers' Federation, credit should be given to its members for their better efforts."

In connection with a High Court judgment, which upheld an employer's appeal against disciplinary action taken by the Board, the report states that it has rendered the Board's disciplinary powers against employers virtually ineffective. (The Court ruled that the Board could not suspend the Melbourne Stevedoring Company, Pty., Ltd., as an employer of waterfront labour. The Board had claimed that two watersiders employed by the company had been drunk during working hours.) The report states that "the loss of effective inspectorial powers has fostered a greater indifference to restrictive practices, breaches of working conditions, drunkenness, pillaging and other forms of misconduct. The situation which is developing is bound to impair industrial efficiency and progress, as well as lower the status of wharf employment. The resurgence of these social evils can only bring the waterfront into disrepute and renew the belief that such practices are characteristic of the industry. It is ironical that four years ago the Board set out to break these practices. Reforms which were gained slowly and laboriously are now virtually breaking up against this legal obstacle. If the situation is not corrected there will be an exorable reversion to 1939-1942 conditions."

The Board also say that welfare facilities for the waterfront workers in many Australian ports are inadequate and are having a bad effect on industrial relationships.

DREDGING & RECLAMATION WORKS AT LITTLE ADEN OIL REFINERY

This Contract comprises the dredging and pumping ashore into reclamation of approximately 6,000,000 cubic yards of material in the construction of a new Shipping Channel and Harbour for the Little Aden Oil Refinery on behalf of the Anglo - Iranian Oil Company Limited.



(Above) View of Reclamation Area where material pumped ashore will form part of site of Oil Refinery (*Right*) Dredging in the Entrance Channel to the new Harbour.

Consulting Engineers : Messrs. Rendel, Palmer & Tritton.

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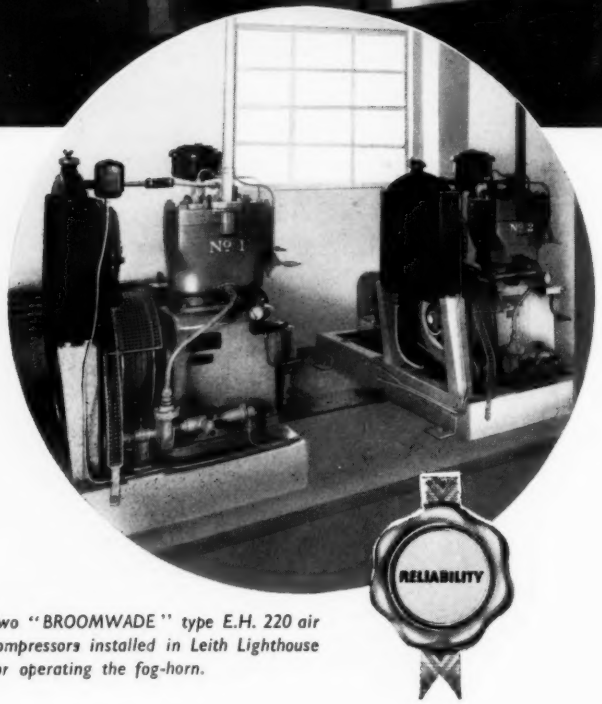

Two "BROOMWADE" type E.H. 220 air compressors installed in Leith Lighthouse for operating the fog-horn.

Photograph by courtesy of British Thomson-Houston Co. Ltd., and Leith Dock Commission.

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The S.S. "Carl Schmedeman" is a new type of ore-carrying ship with its own built-in materials handling plant. The illustration shows just one of the many different kinds of conveyor that Fraser & Chalmers make, both for ships and shore.

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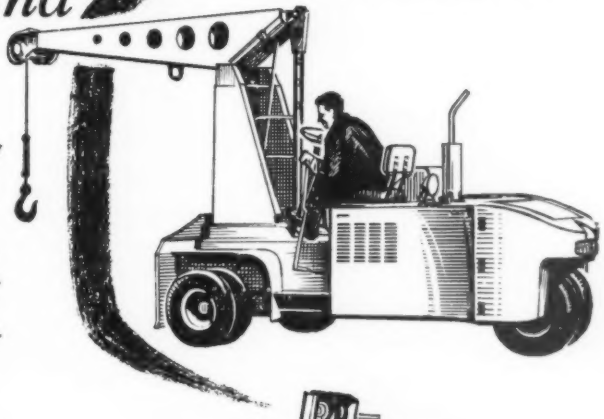

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Colombo installation has proved the superiority of Rubber—*and paid for itself many times over*

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Goodyear Rubber Fenders simply compress when other types of fender shatter or crush . . . returning to their natural shape after taking the most severe, grinding impacts. And as the Colombo installation proves, the life span of these fenders is prodigious —even under gruelling tropical conditions.

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In actual service, in docks all over the world, Goodyear Rubber Fenders have shown conclusively that no other form of protection is so thorough, saves more money all round or lasts for such a long time. The low maintenance and replacement expense makes the overall cost of Goodyear Rubber Dock Fendering far lower than that of older, less protective materials or cumbersome mechanical installations.

Goodyear Rubber Dock Fenders at the new Mutwal Quay, Colombo. Similar fenders at Colombo have already given 15 years trouble-free service in severe tropical conditions and laboratory tests show that they will still give many more years of active life.

Simple Installation—Better Protection. This installation at a dock in the Netherlands shows just how neat and simple Goodyear Rubber Dock Fendering can be.

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The Port of Amsterdam

Post-War Development of an Historic Port

By Ir. T. J. RISSELADA, Chief Engineer, Public Works Department,
Chief of the Harbour Works Division.

(continued from page 232)

V. Technical Development after the Second World War

When rehabilitating the harbour following the serious damage sustained during the recent war, careful examination was given to the port's requirements in connection with the latest developments of shipping and the newest methods for handling goods. This resulted in framing directives for the arrangement and equipment of quays for sea-going vessels. These are:

(a) all antiquated cranes, a few of which had remained intact during the war, should be replaced by up-to-date level-luffing cranes of the portal type;
(b) in connection with interchangeability the gauge of the crane tracks and the current leads should be standardized;
(c) the floors of the sheds should be level with the quays in front of the sheds;
(d) the floors of the sheds and the quays should be provided with flat pavements. For that purpose a pavement of large-sized prefab concrete slabs (about 7-ft. x 7-ft. = about 2 x 2 m.) is the most satisfactory;
(e) the roofing of all sheds should have a clear height of 19-ft. (6 m.) and intermediary supports should not be provided for any sheds of less than 115-ft. (35 m.) in width;
(f) the area of the shed (in which an office for the foremen and an office for the customs should be installed) should, as a precaution against fire hazard, be subdivided into two or more sections (depending upon the length of the shed);
(g) the lighting of sheds should be effected preferably by glass strips at least 7-ft. (2 m.) wide in the side walls continuing over the doors. The glass strip in the side wall, on which the sun's rays strike most intensely, may be omitted if that is considered desirable owing to the nature of the goods stored in the shed;
(h) when installing the artificial lighting, lighting of 0.37 Watt per sq. ft. (4 Watt per sq. m.) of the floor should be taken as a basis for calculation. Preferably fluorescent tubes should be used;
(i) the doors should have a clear height of about 14-ft. (4.20 m.) and a clear width of about 15-ft. (4.50 m.);
(j) the distance between centres of doors in side walls should be 49-ft. (15 m.);
(k) connections should be fitted for the supply of water, lighting and telephones to the ships;
(l) along the quays at the side of the deep water basin there should be at least two railway tracks, and at the side of the basin for inland craft at least one track

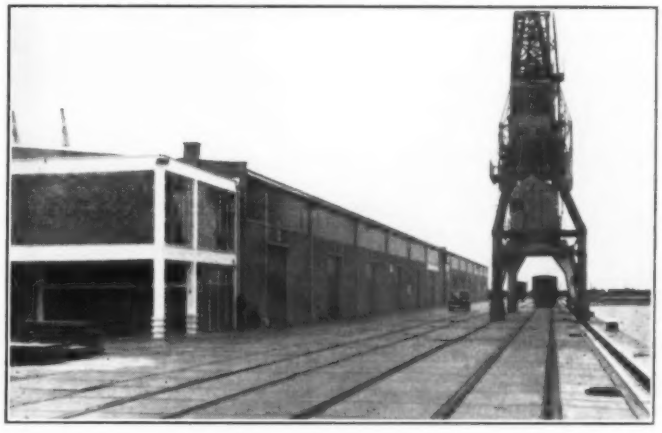


Fig. 9. Up-to-date shed along the Coen Dock built in 1951, with service building on left.

The directives under c and d are connected with the efficient working of fork-lift trucks, which have been introduced and fully accepted since the Second World War for the mechanical transport of goods.

In view of the foregoing, it was found necessary to take more or less drastic steps to modernise a great many of the quays that were still intact after the war.

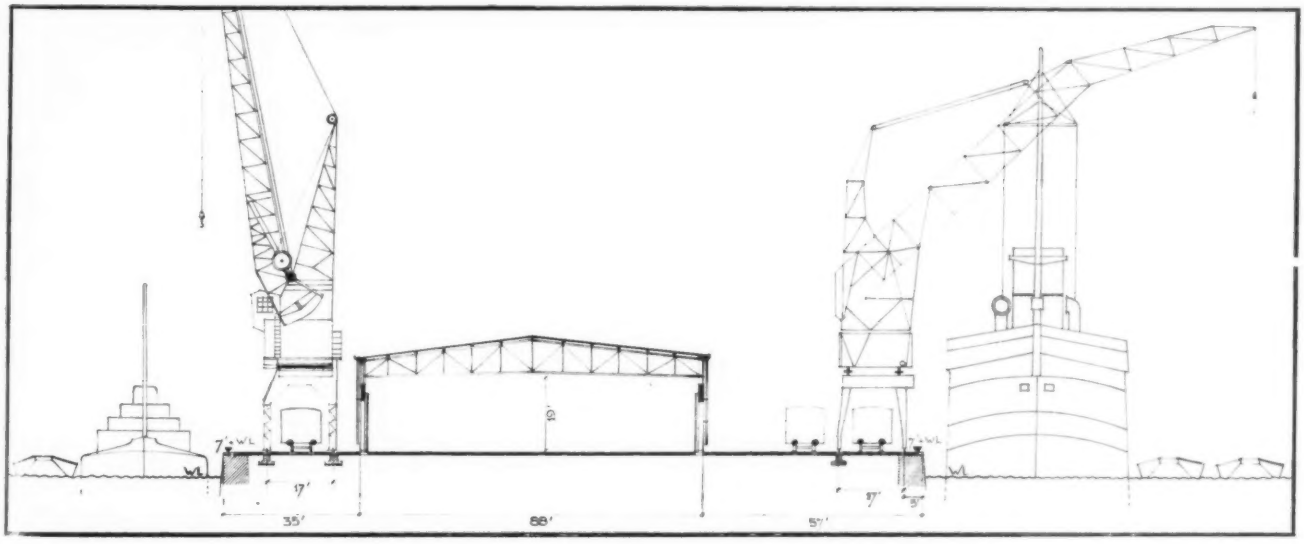


Fig. 10. Cross-section of Pier in Coen Dock.

The Port of Amsterdam—continued

Fig. 11. Piles of a quay wall in the Coen Dock destroyed by the explosion of a bomb.

Sheds.

In practically all sheds built before 1940 the floor was level with the floor of the railway trucks on the quay. This greatly facilitated the transport of goods between the shed and the trucks. However, in order to achieve rapid handling by means of fork trucks, and to make more room on the quay in front of the shed, the platforms along the shed were removed and the floor was made level with the quay; the paving in the shed was also improved to facilitate the quick and smooth movement of the fork trucks. This new method of transport also enabled the number of doors in the side walls of the shed to be reduced without interfering with the economy in moving the goods, thus improving the storage facilities in the shed.

When the " Handelskade " (Commercial Quay) was modernized a number of sheds dating from the time of the construction of the quay were pulled down and replaced by new ones. The modernizing of sheds on the other quays is still proceeding, depending upon the rate at which they can be made available for that purpose.

In the Coen Dock four more sheds were built to provide for additional storage accommodation.

From the investigations which were conducted when the plans for these sheds were prepared, it appeared that the most economical solution is obtained by using a steel skeleton frame, the centres of the trusses being spaced at distances of about 33-ft. (10 m.).

The shed on the first pier (Fig. 9) in the Coen Dock is 88-ft. (27 m.) wide. When fixing that width it was necessary to find a correct ratio between the width of the shed and the widths of the quays on either side (Fig. 10), since the width of the pier—fixed at 180-ft. (55 m.) when the dock was laid out—had to be adhered to. The foundation of the shed consists of reinforced concrete beams supported on concrete piles; on those beams the steel superstructure was erected, the bricklaying of the walls being carried out afterwards. The shed which is 640-ft. (195 m.) long and divided into two sections by a fireproof wall, is covered with lightweight (pumice) concrete roofing slabs. Both the shed and the quays are paved with stelcon harbour slabs. Against one of the end walls of the shed a building has been erected, in which wash-rooms, a messroom, a garage and a gear store have been built.

The large shed of the " Houtveem " (special timber warehouse) is of an entirely different type; it consists of a steel structure with only the side walls filled in with brickwork. The size of the shed is 492 x 328 x 82-ft. (150 x 100 x 25 m.). It is divided by three rows of columns into four divisions, each 82-ft. (25 m.) wide, and is covered with pumice concrete roofing slabs. In front of the shed is a harbour basin with quay for sea-going vessels, behind it a harbour-basin with quay for inland craft. Imported timber is handled by four level-luffing cranes with a lifting capacity of 3 tons at a radius of 105-ft. (32 m.) and of 6 tons at a radius of 59-ft. (18 m.); they are also provided with automatic weighing devices. For transporting, sorting and stacking timber and for its conveyance on the quay for inland craft, fast overhead travelling cranes are fitted in the four divisions. Those cranes have a lifting capacity of 7.5 tons. With the jibs projecting outside the shed at either side, they can reach over the quay for sea-going vessels at one side and over the inland craft, at the other side. For storing plywood an adjacent shed of 295 x 65-ft. (90 x 20 m.) was built.

Quays.

To repair the quay walls damaged during the war, the Coen Dock was enclosed by a dam and partly drained, after the water-tight junction of the dam to the quay wall structure had been ensured by means of steel pile sheeting driven straight through the walls. The level of the water in the dock was lowered by 13-ft. (4 m.), laying all foundations bare and enabling the soil behind the destroyed walls to be dug away.

Plans for the repairs were designed according to the nature of the damage that was discovered, so that operations had to be carried out in several different ways. In some places filling the holes sufficed; in others, the walls had to be pulled down completely, and the foundation slabs had to be entirely or partly replaced; there were also places where even the foundation piles had to be renewed or strengthened (Fig. 11).

For the repair of the part of the Sumatra Quay that had been destroyed during the war, a quite new length of quay wall had to be built (Fig 12). In front of the part of the wall that had been damaged, steel pile sheeting was driven, and a building trench was made inside. The destroyed wall with its pile foundation was then completely removed, and the new wall built. The type of wall decided upon was influenced by the fact that it had to be erected between and united with those parts of the old quay wall that had remained intact.

When the " Handelskade " (Commercial Quay) was modernized, it had to be widened in order to provide deeper water in front

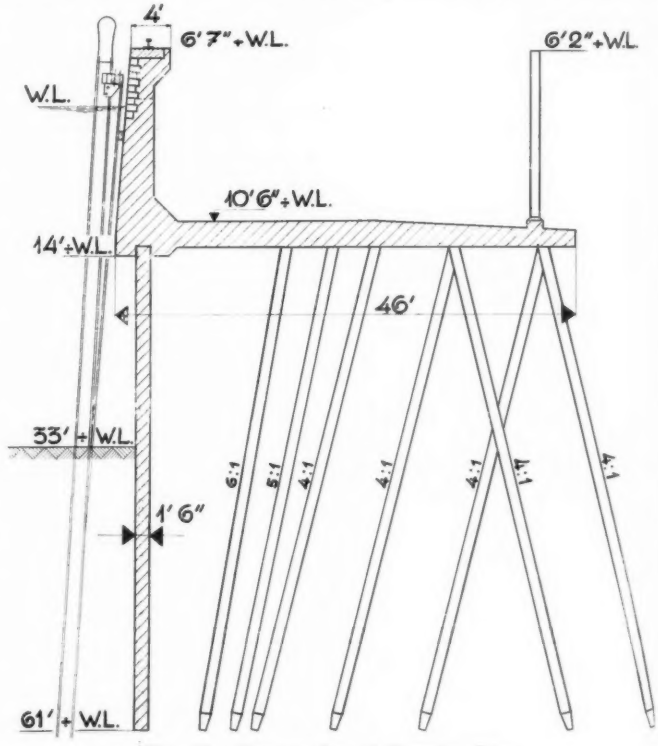


Fig. 12. Cross-section of Sumatra Quay.

The Port of Amsterdam—continued

of the quay and more space on the quay. The structure applied to that end (Fig. 13) is a quay wall with a floor situated at a high level, built over that part of the basin which could not be dredged to the desired depth in view of the stability of the old quay wall. The circumstance that there is only a slight variation of the level of the water in the harbour allows this simple construction to be practised. The floor of the quay wall is just above the average level of the water and consists of a heavy reinforced concrete slab supported by concrete piles. Rubble has been dumped on to the talus under water in order to give as much support as possible to the old quay wall.

It was not necessary to erect such a structure when modernizing the other quays, as the walls built along these quays at the time have another kind of foundation, so that it was possible to get the required depth of water in front of the quay without any special measures being taken. The space on the quays in front of the sheds, which is wider on these more modern quays than on the old Commercial Quay, was further increased by the removal of the platforms along the sheds, and so was considered to be sufficient.

The quay walls built when the harbour basins in the Coen Dock were lengthened (Fig. 14) have deep foundations and are different from the above-mentioned ones. The walls consist of a reinforced concrete floor and a reinforced concrete retaining wall, supported at distances of about 9-ft. (2.75 m.) by L-shaped heavy reinforced concrete beams, in which the heads of the concrete piles are embedded. The wooden pile planking customary with the older quay wall structures was replaced in the present structure by a heavy reinforced concrete pile sheeting, which has a bearing as well as a retaining function. The sheeting piles have sections of 1-ft. 8-in. x 1-ft. 8-in. (0.50 x 0.50 m.). In order to enable jetting to be done while driving the piles the shape of the section has been chosen so that in the joint between two consecutive piles sufficient room is left for a jetting pipe to pass through. That space can, if necessary, be filled in, after the sheeting has been driven.

The quay wall along the harbour basin for sea-going vessels of the "Houtveem" (special timber warehouse) is of the same type. The piles of the heavy reinforced concrete pile sheeting, which was also applied in this case, weighed 10 tons each and were about 56-ft. (17 m.) long.

The presence of the more or less soft strata of clay, peat or fine-grained sand, discussed at the beginning of this article, governed the type of structure chosen when the various harbour basins were laid out. Its influence on the procedure adopted in carrying out the work was especially great in the eastern harbour area, because of the extremely soft top strata found there. In order to reach the firm strata, at about 46-66-ft. (14-20 m.) below water level, pile driving had to be adopted for the foundations of quay walls, sheds, etc. As there is little variation in the level of the water in the harbour, wooden piles are well suited. In view, however, of the difference between admissible loads on a concrete pile and on a wooden pile, a greater number of the latter were needed to bear the same load. This involved less expense, since wooden piles were cheaper per ton of load. Moreover, where wooden piles were adopted, it was easier to adapt their lengths to fluctuations of the depths of strata of firm soil than would have been the case if concrete piles had been used. Also, by driving a greater number of piles, the soft strata of soil was more intensely compressed, causing an increase in bearing capacity and resistance to shear.

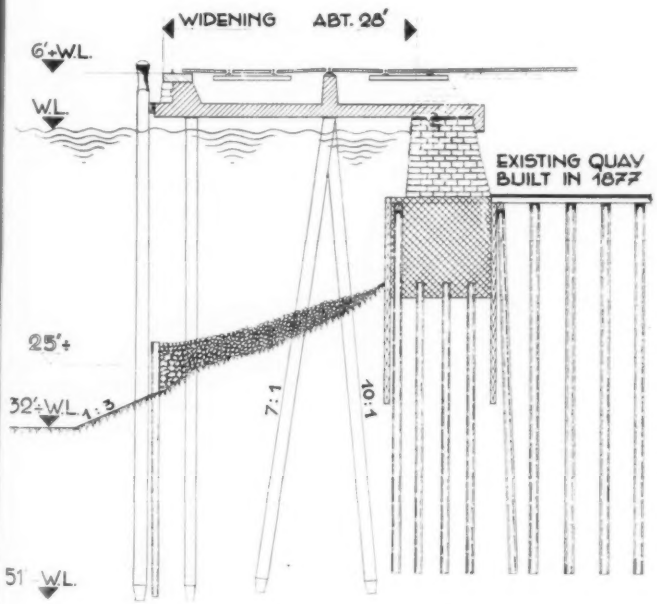


Fig. 13. Widening the "Handelskade" (Commercial Quay).

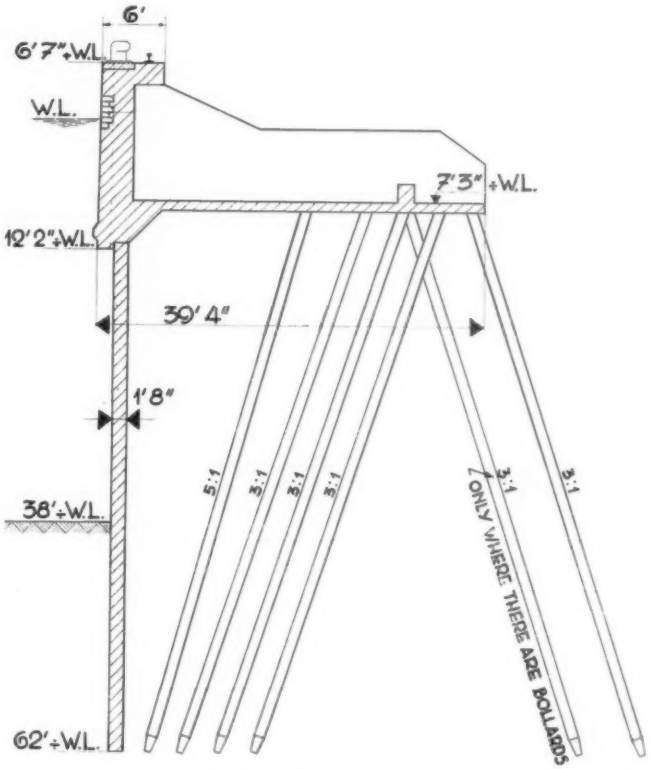


Fig. 14. Cross-section of Quay, Coen Dock.

Because of the marked increase in relative costs since the Second World War, wooden piles that at one time were so suitable for foundations in the port are now used less frequently.

The development of a sounding apparatus that was easy to operate made it possible to carry out further soil and soil mechanics investigations. This overcame the disadvantage of using concrete piles by making it easier to determine their lengths in accordance to the irregularities of the firm stratum.

Taking soundings and boring tests and studying the findings has proved to be a very efficacious aid when solving foundation problems; so this new technique is now applied extensively.

Conclusion.

The foregoing will have shown how the little fishing village at mouth of the Amstel has now become one of the prominent ports of Western Europe, and with what activity and energy the citizens of Amsterdam have succeeded in improving their harbour to meet the most exacting demands of navigation. That activity, will, with the unflagging enterprise of those who work in the harbour, ensure that Amsterdam will maintain her important place in the economic life of the Netherlands and Western Europe.

The Hawkesbury River Highway Bridge, N.S.W.

Description of Construction of Piers and Erection of Superstructure*

By A. R. SHEPLEY, B.Sc., B.E., M.I.E.Aust.

TO replace the ferry service, over the Hawkesbury River, 30 miles north of Sydney, the Department of Main Roads prepared designs for a high level road bridge, and contracts for the construction were let in 1938.

General Description of Work

The superstructure steelwork was supplied by The Clyde Engineering Company, Ltd., and included two 440-ft. truss spans, a 45-ft. plate web girder span, eight 90-ft. plate web girder spans and eight 40-ft. rolled steel joist spans. The roadway is 30-ft. wide providing three traffic lanes, and a 6-ft. footway is cantilevered out on the upstream side.

The construction of the bridge was carried out by Balgue Constructions Pty., Ltd. Four distinct types of substructure were involved. The Sydney Abutment and Pier 1 are founded on sandstone. Pier 2, which carries one end of each of the main spans, is built on an open-dredged caisson founded on sand gravel and rock about 250-ft. below high water level. Piers 3-11 are founded on reinforced concrete piles driven below the level of the river bed. Piers 12-18 and the Newcastle Abutment are capped reinforced concrete pile bents. Fig. 1 shows a longitudinal section of the bridge.

The river at the bridge site has a tide range of about 7-ft., with a velocity of 3 to 4 m.p.h., and a maximum depth of about 75-ft. close to the steep southern bank. On the northern side the water is shallower. Substrata investigation which was made by wash boring showed a considerable depth of silt, soft clay and sandy clay with some sand layers. A suitable sand bed foundation in which to found the open dredged caisson for Pier 2 was anticipated at 170-ft. below low water level. For Piers 3-18, suitable sandy material into which reinforced concrete piles of reasonable length could be driven was anticipated.

Caisson at Pier 2

Description.

The open caisson for Pier 2, sunk by grabbing, is a reinforced concrete shell built up from a riveted steel cutting edge. It has semicircular ends and overall dimensions 51-ft. 0½-in. by 23-ft. 0½-in. The outer walls are 3-ft. thick, and three cross walls divide the caisson into four dredging wells of approximately equal area, the dredging area being just half the total cross-sectional area.

Launching.

The cutting edge was set up on a large punt and sufficient concrete placed above it to allow bulk-heads to be seated against ledges provided in each dredging well. Steel Cofferdam sections attached above the concrete gave the necessary freeboard to allow the caisson to float when the punt was scuttled. This operation was carried out in a launching bay of temporary timber piles, stability being maintained by stabilising tackles. Fig. 2 illustrates this operation.

Extension of the caisson continued while it floated on the bottom bulkheads, cofferdam sections being added to maintain not less than 6-ft. of freeboard. A second set of bulkheads was placed 30-ft. above the bottom set, and flotation was then transferred to these by forcing compressed air into the space between the two sets; the lower bulkheads, held in position only by the water pressure then dropped out. Fig. 3 shows the caisson at this stage.

After correctly locating the caisson and anchoring it in position, it was landed on the river bed by partially releasing the air pressure under the upper bulkhead, the concrete shell being extended as rapidly as possible, the air pressure being gradually released, and only when settlement stopped was the pressure finally released. Penetration into the river bed during the landing process was 10-ft. The caisson was then 84-ft. long from the cutting edge, and weighed 3,000 tons.

*A paper read before the Tasmanian Division of the Institution of Engineers, Australia, and reproduced by kind permission.

The method of launching was incorporated in the design and specification prepared by the Department of Main Roads, and with some minor modifications was successfully followed by the contractor.

Sinking.

After flooding the dredging wells and removing the upper bulkheads, excavation was commenced with a single line grab operated from a steam driven 4-ton revolving jib crane. A clam shell type of grab was used for soft material and a half-tyne type in sand and clay.

Careful checks were made continuously during excavation to ensure that the caisson maintained its correct position and alignment as well as verticality. It was found that the semicircular end wells exerted the greatest controlling effect. There was also a very appreciable lag between excavation and the movement resulting therefrom, as regards the " rolling " of the caisson. In the initial stages of sinking some control was possible by means of tackles set 64-ft. above the cutting edge. These were attached to suitable anchors, two on the northern side and two on the southern side, and by means of crab winches located on the southern bank of the river, a full 20 tons per set could be exerted on the caisson. The sinking rate was about 4-ft. per week.

" Run " of Caisson.

The rate of sinking during excavation had been about 1½-in. per hour. When the cutting edge reached R.L. 79.50 (datum being Low Water Level = R.L.200.00), the rate increased to about 2½-in. per hour, and although observations of sinking rate were not made by instrument at this stage, the caisson continued to sink, the rate probably increasing to 4-in. per hour or even greater.

This marked increase in the rate indicated the possibility of the caisson " running," and safety precautions were taken. Soon after discontinuing excavation, movement became noticeable, and suddenly gaining speed, the caisson disappeared below water level. The cutting edge was found to be at R.L. 26.05 when later determined; the " run " from the last recorded observation of R.L.76.50 for cutting edge was thus 53.45-ft.

Table 1 shows the position of the top of the caisson during sinking. When first landed the top of the caisson was ¾-in. north and ¼-in. downstream of correct position.

TABLE I.

Caisson position during sinking.

Average R.L. of cutting edge	Deviation from correct: Chainage (in.)	Deviation from correct: Centre line (in.)	Remarks
122.42	6⅜ N.	1¼ U.S.	Penetration 10-ft. under own weight; excavation commenced.
121.89	5½ S.	2½ U.S.	
120.88	9 N.	22¾ D.S.	Maximum deviation from centre line.
120.35	11¾ N.	5½ U.S.	Deviation from chainage almost maximum.
119.50	10⅞ N.	8⅝ U.S.	
118.50	1½ N.	6 D.S.	
116.30	7 N.	4 D.S.	
116.30	9⅝ N.	5¾ D.S.	After 24 hours with no excavation.
114.55	12½ N.	7½ D.S.	Maximum deviation from chainage.
113.48	4⅜ N.	1⅜ D.S.	
108.50	8½ N.	3⅛ D.S.	
103.00	8⅝ N.	2⅛ D.S.	
95.00	4⅞ N.	1¼ D.S.	Steady—practically no deviation thereafter.
83.00	4½ N.	1¼ D.S.	

Hawkesbury River Highway Bridge, N.S.W.—continued

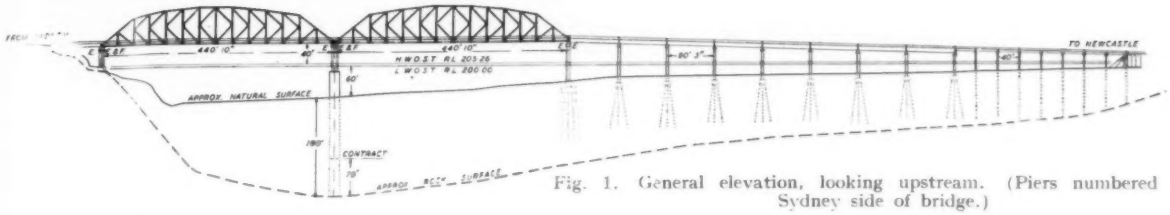


Fig. 1. General elevation, looking upstream. (Piers numbered from Sydney side of bridge.)

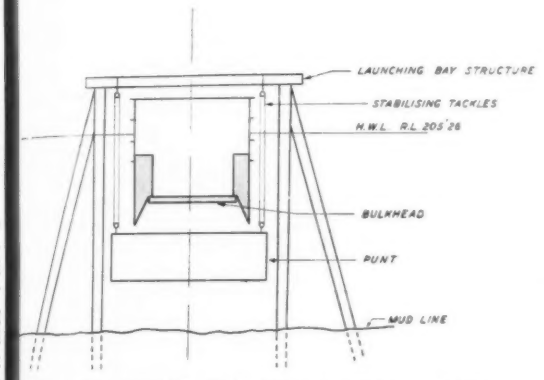


Fig. 2. Punt scuttled by filling with water. Caisson floating on lower bulkhead.

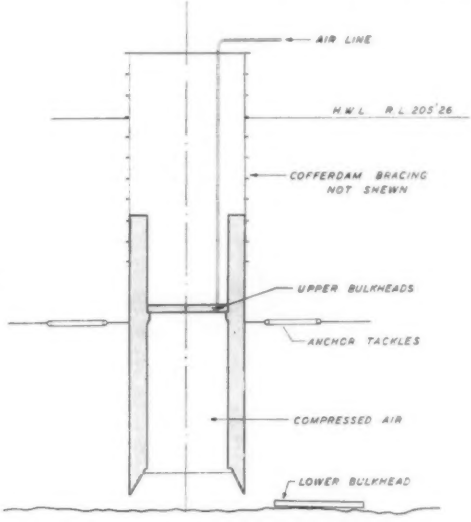


Fig. 3. Lower bulkhead blown off with compressed air, and drawn clear. Caisson floating on air below upper bulkheads.

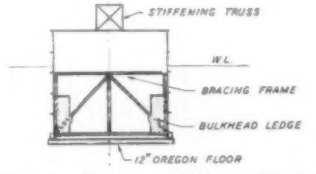


Fig. 4. Pontoon floating with 8-ft. of concrete.

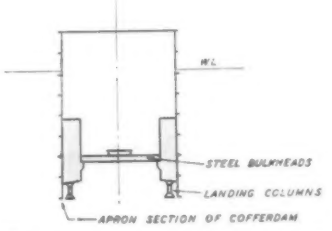


Fig. 5. Caisson floating on bulkhead with apron and landing columns attached.

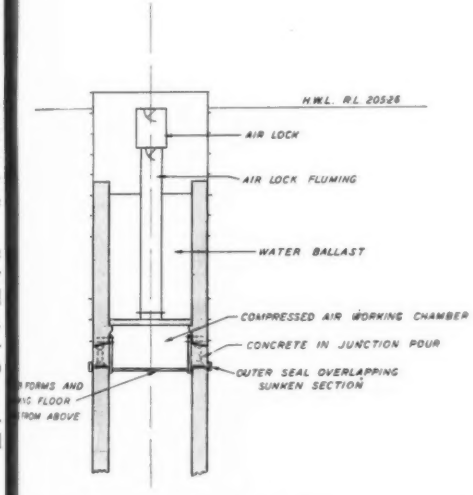
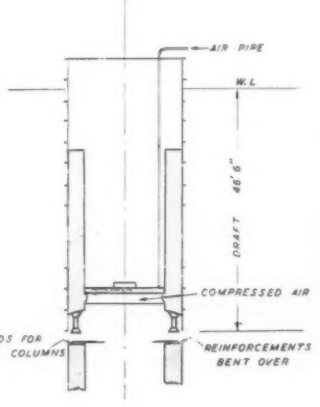


Fig. 6 (right). Upper section floating over sunken section.
Fig. 7 (above). Upper section landed and concrete poured in junction.



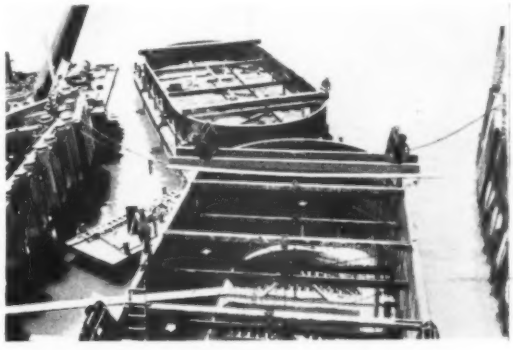


Fig. 8. Floating section of caisson prepared for attaching apron (in background).

Table II shows the sinking rates at the different depths after the difficulties arising from the tendency of the caisson to " roll " had been overcome.

TABLE II.
Sinking rates of caisson.

From R.L. of cutting edge	To R.L. of cutting edge	Hours of Excavation	Rate of sinking (in. per hr.)	Remarks
110.65	102.00	56	1.86	Settlement continued 1.50-ft. after discontinuing excavation.
102.00	95.50	59	1.32	
95.50	86.50	75	1.44	
86.50	83.80	19	1.74	
83.80	81.00	16	2.12	
81.00	79.50	7.5	2.40	Rate increased rapidly until caisson " ran."

Location of Sunken Caisson.

The position of the sunken section of the caisson was determined by observations from shore stations, using the hoist line of a jib crane attached to the cofferdam and carefully plumbing it. These showed that the caisson had " run " on an even keel, and that the position of its centre was 2½-in. north and 1¼-in. upstream of the plan position, and that the average level of the cutting edge was R.L. 26.05.

Building up Sunken Section.

As the sunken section was approximately in its correct position, though 50-ft. below high water level, it was decided to build another section of exactly similar cross section, floating on bulkheads in a similar manner, and land it on top of the sunken section, and join the two together by reinforced concrete placed under compressed air. The alternative was to use a diving bell but this was decided against after discussion with the Department of Main Roads.

In the meantime further wash borings taken around the caisson indicated a satisfactory foundation at about R.L.—35.00 to —40.00.

Hawkesbury River Highway Bridge, N.S.W.—continued

Procedure for Building up Sunken Section.

The procedure adopted and illustrated in Figs. 4-7 was:—

(i) A pontoon was constructed using steel cofferdam sections suitably braced, with a 12-in. oregon floor attached.

(ii) Inside this pontoon, 4-ft. of concrete caisson shell was poured with a ledge for attaching the upper bulkheads used for landing the original caisson.

(iii) Further cofferdam sections were erected and another 4-ft. of concrete shell was poured. The bulkheads were placed in position and sealed to the ledge. See Fig. 4.

(iv) The timber floor of the pontoon was removed, and the flotation transferred to the bulkheads. Three steel landing columns were attached and an apron cofferdam section fabricated below the concrete to form the outer wall of a working chamber. See Figs. 5 and 8.

(v) The concrete shell was built up with the caisson floating, cofferdam sections being added to maintain freeboard, until it was of sufficient length to land on the sunken section. See Fig. 6.

(vi) During stages (i)-(v) the sunken section was prepared for the landing of the floating section. The vertical reinforcement was bent horizontally inwards and concrete pads for the landing columns placed in position. Projecting riser pipes, cofferdam attachment brackets and other obstructions were cut off by means of an oxy-hydrogen torch.

(vii) Under suitable tide conditions, the floating section, which then weighed 1,230 tons, was landed on the sunken section, and ballasted against uplift. Air was forced into the working chamber, and the splice effected. See Fig. 7.

(viii) The bulkheads were removed, as when the caisson was originally landed and the excavation and sinking continued.

Resumption of Sinking.

After the formwork, air locks and bulkheads had been removed, the concrete in the shell was built up a further 24-ft., but the extra load had no effect, the cutting edge remaining at R.L. 26.00.

Excavation was then resumed, the first material removed being tough lumpy clay, which soon changed to fine soft material, indicating cause of the " run." No appreciable movement was caused by excavation nor by the addition of further concrete to make the caisson 198-ft. 6-in. long, the concrete being 24-ft. 6-in. above low water, with the cofferdam 4-ft. above that.

An attempt made at this stage to break the friction by the built-in water jets was unsuccessful owing to the water short circuiting from one set of outlets to the adjacent ones and flowing out of the other riser pipes.

Excavation was resumed until the cutting edge was reached in all wells, still with no appreciable movement. To increase the bearing pressure under the cutting edge, 40-ft. of water was pumped out of the inside of the caisson, but still no movement resulted. Excavation was continued below the cutting edge and creep developed, but it was not practicable to continue excavation further because of the risk of the grab being caught under the cross walls.

Second " Run " of Caisson.

Six external jets consisting of 2-in. diameter pipes were jetted down, three on each side, until the outlets were about 30-ft. below the river bed. Creeping commenced again, but to be effective it was apparent that water jets alone would not be sufficient.

Compressed air blown through the jets caused a noticeable settlement and about an hour after work had been discontinued, and again in the dark, the caisson " ran," fortunately without damage.

This run was 30-ft. 6-in., the cutting edge being at R.L. —4.96 and the cofferdam only 2-ft. 6-in. below L.W.M.

Third " Run " of Caisson.

The concrete shell was extended to 233.39-ft. from the cutting edge, after a series of probes inside the caisson had indicated that there was very little sand overlying rock at about R.L. —40.00, and that the bottom was uneven.

Excavation was resumed to cutting edge, with only slight creep developing. Water jetting was again ineffective, but with air jetting, as before, settlement soon became apparent, and again developed into a " run."

This run was 28-ft. 2-in., with concrete just at low water level, and cutting edge at R.L. —33.44. The centre of the top of the caisson was $4\frac{7}{8}$-in. north and $1\frac{1}{4}$-in. upstream of plan position.

History of Sinking.

The sinking is shown diagrammatically in Fig. 9. An indication of the material passed through as given by results of a bore put down 35-ft. upstream of bridge centre line at pier chainage is also shown.

Final Clearing Up of Excavation.

Excavation was continued until rock was reached at the cutting edge in the downstream well. Soundings indicated about 6-ft. of mud overlying the rock in the upstream well.

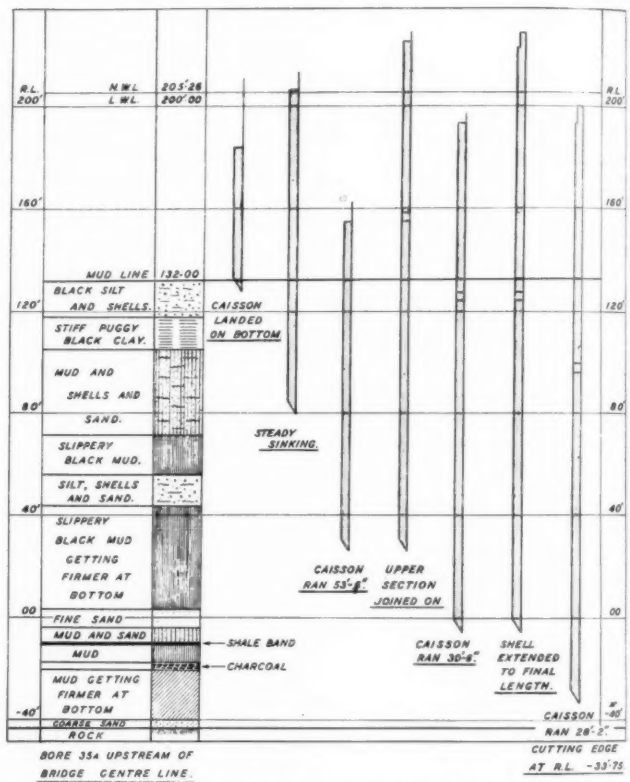


Fig. 9. Diagram of sinking caisson.

An endeavour was made to remove what appeared to be boulders wedged under the cutting edge and cross wall in the downstream well by boring a hole about 2-ft. deep into the sandstone, using a well-boring rig operating through bore casing lowered on to the rock. A " Bomb " made from 3-in. piping, containing up to 5 lb. of gelignite and fuse was lowered into the hole and the casing lifted about 10-ft. before the " bomb " exploded. Portions of boulders accessible were blasted, but those parts under the walls could not be removed. Slight settlement occurred, but further appreciable sinking was considered improbable.

To clean the caisson interior, a water jet system was used for washing the mud down, and an air lift for removing it from the bottom. The unit comprised a pair of jets set directly opposite one another, arranged to discharge horizontally. The working jet was $1\frac{1}{4}$-in. dia. and 3-ft. long, which allowed working under the splay of the cutting edge. The balancing jet was $1\frac{1}{2}$-in. dia. and 1-ft. long. The larger diameter of the balancing jet gave a greater reaction and pushed the working jet towards the surface to be cleaned. Water was supplied from a centrifugal pump at 20,000 g.p.h., and operated at about 12 lb. per sq. in. at the pump.

To avoid a separate pipe line for the air lift to remove the mud washed down, a flap valve was incorporated in the jetting unit, opening inwards, which the jetting pressure kept closed, but under airlift suction it opened and allowed the mud to be picked up. The unit is shown diagrammatically in Fig. 10.

Hawkesbury River Highway Bridge, N.S.W.—continued

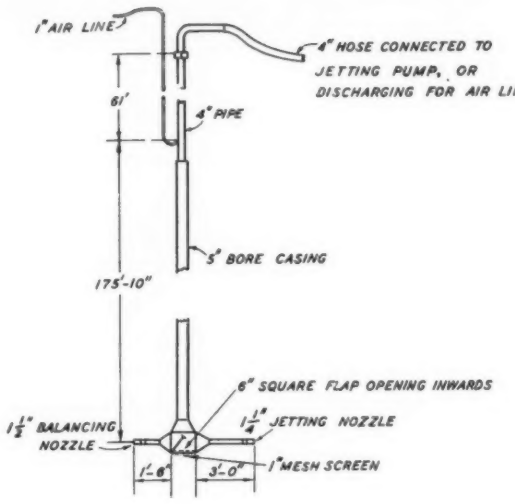


Fig. 10. Airlift and jetting unit.

The whole assembly was suspended from a jib crane, and the washing down process extended to about 30-ft. about the cutting edge. The compressed air for the air lift was supplied by a 160 cu. ft. per min. compressor, pressure varying from 30 to 35 lb. per sq. in., and solid materials of up to 1 lb. in weight, were easily lifted from the bottom in the cleaning-up process. For cleaning-up below the level of the cutting edge. particularly in the upstream well, the air lift was used on a plain pipe.

The final foundation before placing the concrete seal was uneven, and comprised 50-60 per cent. rock or boulders, 30-20 per cent. sand and gravel overlying or between rock and boulders, and the balance sandy mud in crevices or places not completely cleaned out, principally in the upstream well, where the excavation was taken 8-ft. below the cutting edge.

Generally the foundation was higher on the south side, and at the downstream end. The cutting edge was at R.L. —33.75, and the average depth of the foundation was R.L. —37.80, the deepest point being R.L. —41.30 or 247-ft. 10-in. below high water level.

Concrete Seal in Caisson.

The caisson was sealed by a " plug " of concrete which was designed to extend to 25-ft. above the cutting edge. The concrete was placed by bottom dump self tripping buckets with a top cover to prevent concrete washing when lowered, operated from single line crane suspension. A total of 580 cu. yd. of concrete was placed in a continuous operation, at an average rate of 12¾ cu. yd. per hour. The concrete was mixed adjacent to the southern shore, and the buckets were transported to and from the caisson on a small punt hauled along a travelling line by a winch.

When buckets landed on the bottom the tripper device operated to allow the bottom doors to open. By lifting the bucket very slowly for about 10 seconds, time was given for the concrete to flow out with a minimum of disturbance. Previous experience in placing concrete seals under water in the piled pier foundations by similar means had demonstrated that good quality concrete could be placed if adequate precautions were taken. An important detail was the provision of an effective swivel in the hoisting line to prevent spinning of the bucket and facilitate placing in correct position. Special ballbearing swivels were designed and functioned satisfactorily.

To ensure a uniform level over the whole area, soundings were taken regularly by means of a 6-in. square plate attached to a flexible wire sounding line. It was expected that about 6-ft. of laitance would be formed, and investigation made with the sludger of a boring plant 48 hours after placing showed an average depth of 7-ft. 6-in. of laitance above sound concrete. The thickest portion of the seal was 34-ft., and the thickness above cutting edge level was 26-ft. 3-in.

Completion of Pier.

The caisson was capped with a heavily reinforced concrete cap 7-ft. thick. The 190 cu. yd. of concrete in this pour were placed in one operation. The heat generated and consequent expansion caused slight transverse cracks in the caisson shell surrounding it, but these disappeared when the concrete in the cap cooled.

Two 12-ft. octagonal reinforced concrete shafts braced by a crosshead were built on the cap to carry the main truss bearings. The overall height of the pier is 282-ft. The foundation load is about 8,500 tons, or eight tons per sq. ft. over the caisson area.

(to be continued)

Dredger Buckets and Tumblers

Their Design, Construction and Materials

By J. LOMAS

Dredger buckets are mounted on an endless chain, built up of steel links, which travels over hexagonal or octagonal tumblers, one being fixed at the top of a jib or ladder arrangement and one at the bottom. The tumblers are revolved by mechanical means, and carry the buckets round and round in an elliptic cycle. When they reach the bottom, the buckets scoop up the material they are desired to remove, and travelling upwards, finally deposit their contents on board the dredger ; into a barge alongside ; or take them out to sea and dump them.

These buckets are continually working in a mixture of sand, silt, water, grit, etc., a combination that sets up extreme and excessive wear on the working parts. As they are constantly working under water, lubrication is impracticable, and for this reason the materials used in their manufacture must be such as will resist this abrasive action.

The parts most subject to wear are the lips, the eyes in the base and the hinge pins. Where possible, these are all made of austenitic manganese steel, as it has been found that this material, by reason of its exceptional resistance to wear, combined with toughness, is the most suitable for the purpose. The steel in question contains from 11 to 14 per cent. manganese.

These wearing parts, where they are renewable, should be as far as possible interchangeable, to enable replacements to be made with the least possible delay. It will be readily understood that the time lost in waiting for repairs and renewals, should the material be faulty, might result in a possibly serious delay of dredging operations. A defective connecting pin, for example, would be quite sufficient to let all the buckets down and throw the dredger out of commission for some considerable time. Moreover, the design must be of a simple character, because dredgers often have to operate in parts of the world where means of adjustment, replacement, etc., are exceedingly limited.

Although there are various types of buckets made, the general design remains largely the same, the modifications depending on the type of material to be scooped up, the capacity of the buckets, and to some extent, the predilections of the designer. The form and method of construction are changed rather than anything else. Modifications of form are intended to make the bucket discharge its contents completely into the shoot when passing the upper tumbler, while at the same time, the construction must be strong enough to obviate their being stretched or drawn out whenever any unusual resistance is encountered. This is important, to reduce the expense and time occupied in making repairs to a minimum.

The bucket is broadly a truncated cone with non-parallel planes. The general bottom plane of the corner forms the open side of the bucket. It is desirable that the bucket should not have acute angles, as this is liable to cause sticking of the material when dredging operations are in progress. Buckets made of steel plate are lighter and more readily repaired than heavier types, but on the other hand, they have to be repaired more often because of the working loose of the rivets by reason of the continual deforma-

Dredger Buckets and Tumblers—continued

tion during scooping, even if the bucket resumes its form afterwards. The bucket is sometimes dented when right under the bottom tumbler because of the pitching and tossing of the vessel. If the bucket encounters extremely resistant material, this again may cause the dredger to move up and down.

A Bucket for Light Work.

Fig. 1 shows a built-up type of bucket for light work. It is usually of small capacity (less than 700 cu. ft.). The body portion is made up of low carbon steel plates, bent to shape and riveted up. The lip is usually of hard rolled steel or cast austenitic manganese steel to resist the wearing action. The bushes in the base portion, forming the eyes for the connecting links and pins, are made of either forged or cast manganese or nickel chromium steel.

The weak point in this design is, as stated, the tendency for the rivets to shear. These rivets connect the lip to the mild steel body plate, but if the work required by the buckets is not too heavy, and the rivets are designed strongly enough to resist the shearing action, failure at this part is not common.

The same applies to the type shown in Fig. 2. This design is made up of a toughened steel back casting, with a mild steel body plate riveted on. The part that receives the wear is reinforced with a cast manganese steel lip, which can be renewed when required. The eyes are fitted with manganese steel bushes as in Fig. 1.

Cast steel buckets are used whenever large dredgers are required. In Fig. 3 is seen a bucket in which the low carbon steel body plate is dispensed with, the manganese steel lip being riveted directly to the cast steel bucket back. In this design, the shearing of the lip rivets is prevented by supporting lugs cast integrally with the body part. These form a seating on which the edge of the lip abuts, taking the load off the rivets. In some instances a ridge is cast all round the edge of the body portion to support the lip. This, of course, increases the resistance of the rivets to shear.

Some dredger users have suggested that a manganese steel lip with the portion fitting to the body part should be made U-shaped. This idea, while preventing the shearing of the rivets, greatly complicates the fitting up of the buckets. To make a manganese steel lip of this description, with a groove to fit over the edge of the body portion, would not be easy from the steel foundry point of view, and it must also be borne in mind that manganese steel cannot be filed, and is machinable only with special tools and technique. The only practical method of finishing it is in this instance grinding. It follows, therefore, that the groove would have to be cast very evenly, exactly to the size, shape and form of the bucket back. The expense entailed in grinding and fitting would be considerable, and moreover, the holes for the rivets would have to be cast in, exactly to centres and size. In such a design there would also be two sets of holes to be brought into alignment with those on the back of the bucket, greatly increasing the difficulties of fitting and riveting. The plain curved lip is far simpler, and if supporting lugs are cast on the body portion, there is no danger of shearing the rivets.

Another feature of this design is the addition of manganese steel wearing plates riveted to the feet of the buckets. These plates withstand the constant rubbing over the tumblers, and also admit of renewal, without the cost of a complete new bucket.

When a bucket is made wholly of cast steel, the cutting edge is fixed to the inside, where it functions as a wearing plate as well, at the point where the greatest wear of the buckets is met with, while in addition the edge cannot be so easily torn off. The wearing surface of the buckets should be as broad as possible. This makes the bush longer and mitigates excessive and inevitable wear caused by the tumblers.

Dredger buckets are frequently made throughout of manganese steel, but their use is confined mainly to such work as the dredging of rivers for tin, etc. For heavy duty in harbours, etc., a dredger bucket similar to that shown in Fig. 4, which has manganese steel digger teeth fitted round the lip of the bucket, is more commonly employed. By the addition of such teeth no difficulty is experienced in dealing with stiff materials or even heavy boulders such as are often met with in clay of glacial formation.

Fig. 1

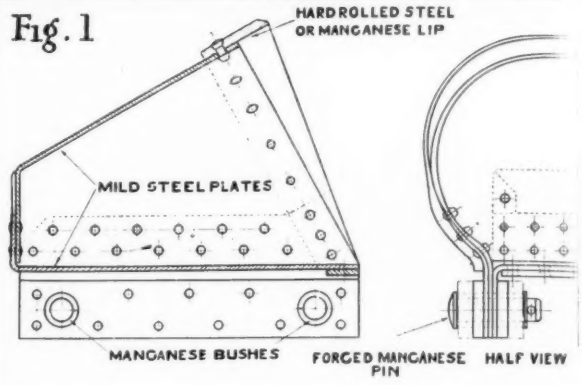


Fig. 2

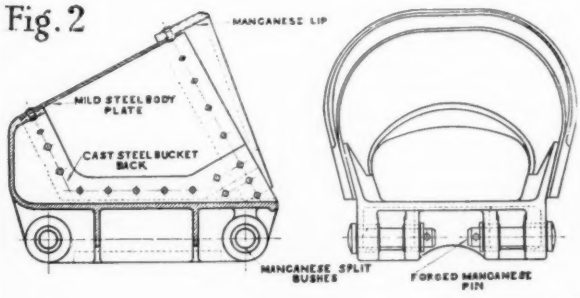


Fig. 3

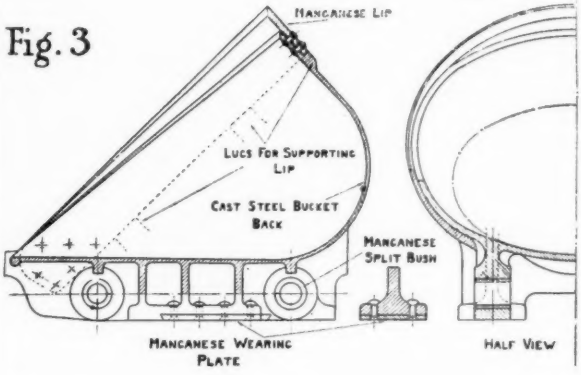
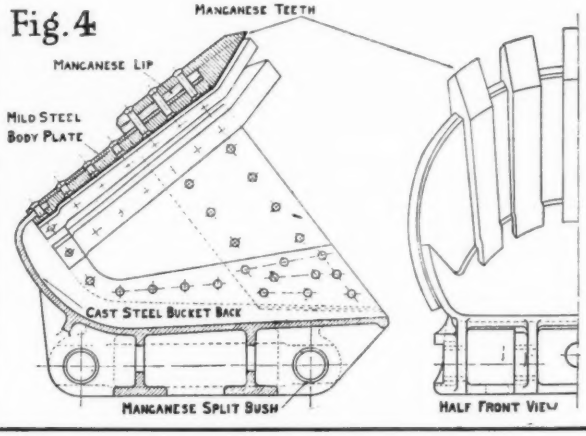


Fig. 4



Capacity of Buckets.

Dredger buckets will easily lift stones weighing from 30 cwt. to two or even three tons each, bringing them up to the surface and within the range of a deck crane. Over a period of twelve months, one British river was dredged to the extent of 417,963 cubic yards. Of this, two-thirds was hard boulder clay, containing 1,651 stones

Dredger Buckets and Tumblers—continued

varying in weight from 5 cwts to 4 tons each, of which 1,523 were raised by dredgers, unaided by divers. In addition, numerous tree trunks, ranging in length from 10 to 20-ft., 16 tree roots and stumps, and other miscellaneous obstructions were removed.

The above details deal broadly with the design and construction of dredger buckets, but developments have taken place and continue to take place, not only in the design of the buckets, but also in the materials of which they are made. Nickel chromium

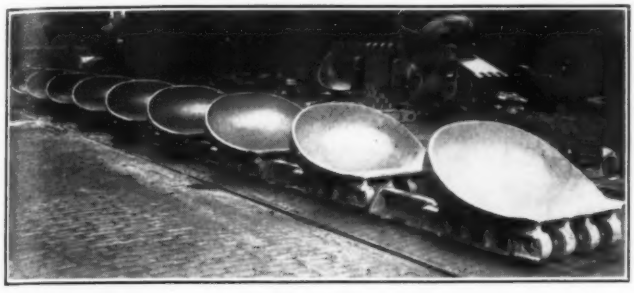


Fig. 5.

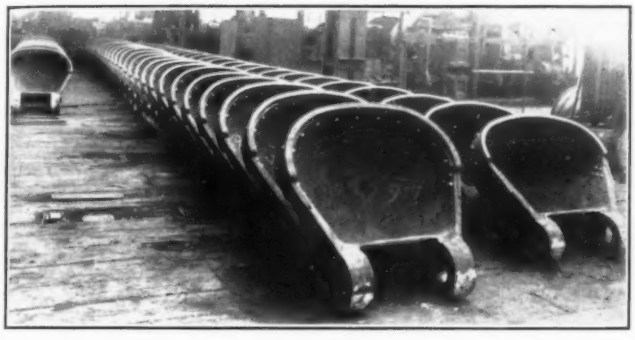


Fig. 6.

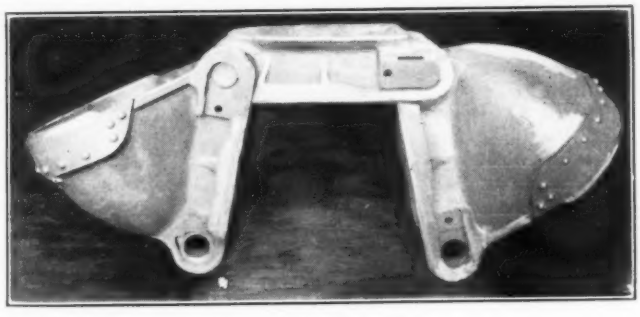


Fig. 7.

steel, for example, has established a claim to consideration. Fig. 5 shows a row of cast steel dredger bucket backs weighing over 10½ cwts. each. The buckets are connected by cast steel links, which are also fitted with manganese steel bushes. This particular type of bucket has a fairly large area of base, which has to be cast perfectly flat. This gives a large bearing surface on the tumblers and reduces the wear.

Fig. 6 shows a number of complete dredger buckets close-connected but not by trays. These have a capacity of 8 cubic feet and weigh 16½ cwts. each. The trays sometimes used to connect the buckets weigh 10½ cwts. each. Both the buckets and the trays are made in nickel chromium steel, which material, while capable of being machined by ordinary methods, has high resistance to wear. The buckets have a strip ⅜-in. thick cast down the centre at the back. The addition of this strip, besides increasing the strength, also takes some of the wear caused by spill. Renewable lip castings in manganese steel are cast on the outer edge of the body to support the lip. The trays serve as a connecting link between the main bucket and at the same time catch the spill. They also protect the back of the main bucket from damage by large dredged stones on leaving the tumbler.

Fig. 7 shows two complete dredger buckets connected by a tray, of the same type as Fig. 6. The back lug of the bucket fits between the two front lugs of the tray, and the back lug of the tray between the two front lugs of the bucket. Nickel chromium steel pins of substantial design pass through the eyes in the lugs of both buckets and trays, and by this means a chain of buckets and trays is built up. The head of the pin is L-shaped and fits snugly beween lugs cast on the sides of the bucket, which prevent the pin from turning. As an additional precaution, the pin is also fastened by a countersunk-headed bolt passing through the head of the pin and the side of the bucket body.

The bucket and trays are free to turn round the pins, and when in action are thus able to follow the shape of the tumbler when passing round the end of the dredger ladders.

It will be observed that the back eye of the bucket is specially bushed. The semi-circular part which takes the pull, and in consequence is subject to the most wear, is made of manganese steel. This is ground to fit the machined semi-circular portion of bucket eye, and is held in place by a wedge piece, which, not having the same amount of wear, is made in ordinary quality cast steel. The back of the wedge piece is slightly tapered to give a good driving fit in the eye of the bucket.

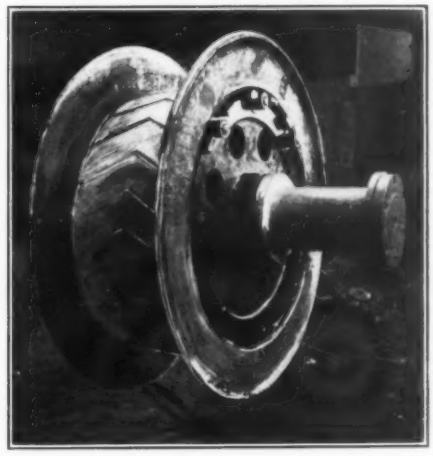


Fig. 8.

Dredger Tumblers.

The tumblers of dredgers are also of great importance. Fig. 8 shows a built-up type of bottom tumbler. The body measures 7-ft. 6-in. in diameter by 3-ft. wide and the total weight of the complete tumbler with shaft and fittings is 10½ tons. The tumbler is circular. The outer flanged shell or tread ring is made of austenitic manganese steel and this itself weighs over 70 cwt. The shell is wedged on to a cast steel centre with low carbon steel wedges. Bearing surfaces for the wedges are machined on the periphery of the cast steel centre, and corresponding bearing surfaces are ground on the inside of the manganese steel shell. Large mild steel bolts equally pitched around the circumference also help to keep the steel in position. The bolts pass through U grooves cast in the rim of the centre, and have large washers at each end. Part of the washer fits into semi-circular recesses cast in the side of the shell, and the other parts butt against the face of the cast steel centre. When the nuts are screwed up, the washers fit tight up against the rim of the centre and the side of the shell. Hard wood wedges are also driven into the intervening spaces between the wedges. The cast steel centre is bored out and faced at each end and a forged steel shaft is forced in by hydraulic pressure of not less than 130 tons. The pressure, of course, depends on the diameter of the shaft to be driven in, the one shown being 14-in. dia. The shaft is also fastened in by mild steel keys, two driven in from each end of the bore.

The shaft is machined all over and sleeve castings made in chromium alloy steel, specially heat-treated, one at each end, are shrunk on. The inner ends of the sleeves have jaws cast on which fit into suitable recesses cut in the boss of the centre. At the extreme ends of the shaft specially built up cast steel collars are fitted. The collar consists of two rings, one in halves, which fits into a groove cut in the shaft. This ring is placed in position,

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The St. Lawrence Waterway

Plan will develop Canada's Resources

A paper on "The Development of the St. Lawrence Waterway" was presented recently by Mr. J. F. Grandy, of the Office of the High Commissioner for Canada, before a meeting of the Commonwealth Section of the Royal Society of Arts. He suggested that the completion of the project would have far-reaching results on the economy of Canada through the extension of bulk traffic in iron ore, grain and coal.

Mr. Grandy commenced his address by tracing the development of the waterway and said that the St. Lawrence and Great Lakes system together might best be considered as a river rising in the middle of a continent over 2,000 miles from the Atlantic, that was, from the head of Lake Superior to Belle Isle, where the Gulf of St. Lawrence merged into the Atlantic. The first 1,000 miles from Belle Isle to Montreal were freely navigable during the open water season. The rest of the system—the upper St. Lawrence, the Great Lakes and their connecting channels—consisted in their natural state of large freely navigable sections divided by natural obstacles which barred navigation from passing from one section to another. The main barriers were the various rapids in the St. Lawrence river itself, the Falls at Niagara, and the rapids at Sault Ste. Marie.

The development of the St. Lawrence Waterway—the artificial improvement of the channels where there were rapids or other barriers—began around 1700, when a canal at the River St. Pierre, near Lachine, was constructed. By 1900 there was a continuous system of navigation of 14-ft. depth from the upper lakes to Montreal. To-day there was still only a 14-ft. system between Prescott and Montreal, while above Prescott 20-ft. was available up-bound and 25-ft. down-bound. The only important obstacle to deep water navigation was the section between Prescott and Montreal.

History of Negotiations.

Mr. Grandy then mentioned the negotiations between Canada and the United States for the development of the waterway. In 1910 the International Joint Commission was established, in accordance with the Boundary Waters Treaty of 1909 between Canada and the United States, primarily to deal with problems affecting the use of waters constituting or crossing the international boundary. Ten years later the two governments referred the whole question of navigation in the St. Lawrence to this Commission. In 1932 the two countries signed a Treaty providing for the construction of the deep waterway. The Treaty, however, failed to obtain a two-thirds majority in the United States Senate. In 1941 the Treaty was replaced by an agreement which is, in large part, the basis from the engineering point of view of the present plans. This agreement provided for the construction of the remaining links of a 27-ft. waterway from the head of the Great Lakes to Montreal, and a power scheme in conjunction with navigation works in the International Rapids Section of the St. Lawrence. The work that remained to be done to complete the scheme envisaged in the agreement was as follows: Some channel dredging in the upper lakes; dredging in the Welland Canal; the construction of a channel in the Lake St. Francis section; the construction of a channel, a short canal, and several bridges in the Soulanges section; and finally the development of the Lachine section, either for navigation alone, or for navigation and power. All this was apart from extensive work in the International Rapids Section.

Water Level Condition.

The speaker then explained why the proposed waterway must be conditional upon an international power development. "The Boundary Waters Treaty of 1909 provided among many other things that either country could, in effect, do what it liked on its own side of a boundary water as long as it would not thereby affect the water level. If it were feasible to deepen the present 14-ft. canals to 27-ft., Canada could develop its own deep waterway without affecting the level of water in the river, and therefore without depending in any way upon United States co-operation. But this would be uneconomic; it is too expensive to cut that much depth in what is mostly solid rock. The only practical method is to provide depth by damming the river at a suitable point, and damming a boundary water must be an international project."

The cost to the Canadian Government of the proposed navigation works between Montreal and Lake Ontario, and of the dredging that remained to be done in the Welland Canal, had been estimated at about $250 million, at December, 1950, prices.

Heavy Movement of Bulk Cargoes.

When the project was first put forward, and later when the first Treaty was signed, the movement of grain from the Western prairies was by far the most important function the waterway was expected to serve. It still remained one of the most important functions, but it was now expected to be surpassed in importance by the movement of iron ore from the Quebec-Labrador region through the new port of Seven Islands, up into Lake Erie to serve the steel industry in that area. Without the St. Lawrence Waterway the ore would move by sea to Baltimore for use by the Atlantic coast steel mills, or for transhipment by rail to Pennsylvania, but the least expensive way of getting ore from Severn Islands to Pittsburgh would be through the St. Lawrence Waterway.

The difference in transportation costs was so significant, Mr. Grandy continued, that it was thought that when the deep waterway was in operation the extraction of the 10 million tons of ore a year which was now planned could be doubled. The direction of this movement was particularly fortunate, for previous studies of potential traffic had had to assume a good deal of movement of shipping from east to west in ballast. There might very well therefore be a movement from east to west of 15 million tons of iron ore, and from west to east something like 10 million tons of grain and possibly four million tons of coal.

Arguments Against the Project.

Referring to arguments against the scheme, Mr. Grandy said they came from a variety of sources. Many of them were organisations who believed, rightly or wrongly, that the opening up of the St. Lawrence to deep water navigation would be a serious threat to their commercial interests. Some of the United States railways and a number of Atlantic ports had played a leading role in opposing the project for reasons such as this.

On the question of ice, Mr. Grandy said that the navigation facilities would be ice-bound for about five months in each year, but this had been taken fully into account in the estimates of traffic that had been made. He mentioned that the canals at Sault Ste. Marie, which are ice-bound for just as long, nevertheless manage to handle more traffic in a year than the Panama, Suez and Kiel Canals taken together.

In conclusion the speaker said: "It is not easy to put into precise monetary terms the value of the contribution the new navigation works will make, but one estimate that has been made is that it will result in a saving in transportation costs of $15 million a year."

Dredger Buckets and Tumblers

(continued from previous page)

and the outer solid ring is then fitted and bolted to the inner ring. Lateral movement of the sleeve is thereby prevented.

There is one drawback to tumblers of this type, namely, that in course of time, the wearing plates become loose. The first step in improving upon this type was the production of a one-piece tumbler with splits in the base at each end. Nevertheless, notwithstanding the shrinking of rings or hoops on the boss, the shaft sometimes worked loose. A more solid tumbler than the built-up type or even than the split boss type was necessary, and eventually a solid manganese steel dredger tumbler was produced. The first successful tumbler of this type was produced in 1929, and since then a very large number have been made. In not one instance has it been reported that the shaft has worked loose.

A typical tumbler of this type weighs 10 tons 8 cwts. The diameter over the flanges is 7-ft. 3-in., width over flanges 3-ft. 2-in., length of shaft 7-ft. 8-in., diameter of shaft 11-in.

Oil Pollution Investigation

With the object of discovering seasonal changes in the speed and direction of the ocean currents which are believed to carry oil patches to the beaches of the United Kingdom, arrangements have now been completed by the National Institute of Oceanography and R.A.F. Coastal Command for the dropping of plastic drift envelopes in the Atlantic Ocean to the west of the British Isles. Weather permitting, aircraft of Coastal Command, each carrying a scientist from the Institute, will make the first dropping flights on January 20th, 1954. Further flights will be made during the spring, summer and autumn.

A reward of half-a-crown will be paid to the sender of each post-card (contained within the envelope), which is returned to the National Institute of Oceanography, Wormley, near Godalming, Surrey, with the simple questionnaire which is printed upon it filled in.

The dropping track on this winter flight will extend in a rough semi-circle from the centre of the Bay of Biscay to half-way between the north of Scotland and Iceland. The total length of the track is some 2,100 miles, and one envelope will be dropped for every mile flown. As the speed of the aircraft will average about 125 knots, the envelopes will be dropped in bundles of ten, secured with gummed paper strip which will detach itself after a short time in the sea. Envelopes so dropped at one position will be dispersed over a wide area before they reach tidal waters.

From existing knowledge of the currents in the dropping area, it is expected that the first of the envelopes will strand during the middle of March, but their date of arrival will depend very largely on the wind during the time they are afloat.

Arrangements have also been made with the Meteorological Office and the Netherlands Weathership Commission for Ocean Weather Ships at Stations "India" (61°N, 15° 20'W) and "Juliett" (52° 30'N, 20°W) to drop one plastic envelope at noon each day during the whole of 1954.

Less Foreign Trade in U.S.A. Ports

New York was the only U.S.A. port to register an increase in the amount of foreign trade handled during the first six months of 1953. The increase was 1.6 per cent. compared with a decline of 9 per cent. throughout the rest of the country.

Figures issued by the Port of New York Authority show that during the six months under review a total of 17,445,580 tons passed through the New York Customs district (20.7 per cent. of the total U.S. foreign trade), compared with 17,171,730 tons during the corresponding period of 1952. The total of foreign trade dealt with in U.S. ports during the January-June period is estimated at 84,226,654 tons, compared with 92,512,783 tons in the corresponding period in 1952.

The increased amount of ores, minerals and oil cargoes handled at New York more than offset the decline in grain and coal exports, which were the cause of the fall in tonnage at other U.S. ports. U.S. coal exports declined by 10 mn. tons and grain showed a decrease of 2,600,000 tons.

New York handled 34 per cent., or 6,261,197 tons, of the total foreign cargo trade, compared with 33.4 per cent., or 6,726,666 tons, in 1952. The remaining six Atlantic and Gulf Coast Customs district handled 6,728,380 tons of foreign cargo, compared with 7,245,299 tons in the first half of 1952, a decline of 7.1 per cent.

Exports from the U.S. during the first half of last year, at 7,300,000 tons and the New York exports, at 2,400,000 tons, were the lowest half-yearly figures recorded since the end of the war. Imports, on the other hand, declined during 1951, and only began to increase by small amounts, quarter by quarter, throughout 1952. This increase continued, to a certain extent, at the beginning of 1953 and, in the second quarter, general cargo imports rose sharply. In view of this, both the total U.S. general cargo imports, during the first half of last year, totalling 11,200,000 tons, and the New York share, 3,800,000 tons, are record figures for a half-year period since the end of the war.

Manufacturers' Announcements

The Bray Hydraloader

The Bray Hyrdaloader is already well known as a useful power-shovel, with a high operating efficiency secured by its special "power-crowd" hydraulic bucket-control. It has now been announced by the makers, Messrs. W. E. Bray and Company Limited, of Feltham, Middlesex, that the scope of the Hydraloader has been further extended by new modifications which increase the loading height to 11-ft. 6-in. and correspondingly extend the forward reach. It is claimed that apart from increasing the height of the dumps which can be made, the Hydraloader can now be used for loading into the highest standard railway wagons. Bulk material of all kinds can thus be loaded direct from mail-side dumps into open wagons, without the capital cost of a hopper, telpher or crane installation. High-side lorries and hoppers can be loaded with ease without the need of ramps or conveyors.

Handling of Steel Plates

A new Plate Lifting Clamp has been designed by Chamberlain Industries, Ltd., London, which has greatly simplified the handling of mild steel plates. The clamp combines strength with simplicity and lightness, has a bulldog-like grip, but is light to handle due to its scientific design.

The "Staffa" Clamp.

By the "Staffa" method, the grip automatically increases with the greater applied load, but immediately the plate comes to rest and the weight is relieved, the clamps automatically relax their grip for rapid removal. The teeth of the gripping edges are hardened so as to maintain their grip and give many years service.

Simple to operate, and designed to be used in pairs, these clamps are available in two sizes, type PC/A1 of one-ton capacity and suitable for handling sheets from ⅛-in. to ½-in. thick, and type PC/B2 of two-ton capacity for plates ½-in. to 1½-in. thick.

Travelling Tower Crane

The Neal Travelling Tower Crane is an entirely new product of R. H. Neal and Co. Ltd., and is particularly valuable for modern building construction where its ease of erection, wide range of operation, high lift and long reach fulfils a long felt need.

The crane is of the self-erecting type, and under normal conditions the 80-ft. high tower with 50-ft. cantilever jib can be raised by its own motor into the working position in a matter of a few minutes. It runs on rail track laid close to the building under construction and can lift and place loads at almost any point over an area of more than 100-ft. diameter; at the same time it can travel the length of the building.

The capacity is 2½ tons at 16-ft. radius, reducing to 12 cwts. at the maximum radius of 53-ft. and the maximum height of lift is 66-ft. The crane is all electrically operated from a driver's cabin which can be placed at any convenient height up the tower to give the best view of the work.

New Type Diesel Shunters

Latest developments by W. G. Bagnall, Ltd., locomotive builders of Stafford, are diesel mechanical shunters of the 0-4-0 and 0-6-0 type designed primarily for industrial shunting in steel works, factories, mines, harbours and on plantations.

These locomotives are powered by McLaren cold-starting Diesel engines giving four speeds. The changes are effected by four oil operated cone type couplings. The reversing mechanism consists of bevel gears and reversing is effected by means of a simple dog clutch. The final drive is from a jackshaft with fly cranks connected to the locomotive wheels by coupling rods.

Frames, superstructures, wheels and axles, brake and draw and buffing gear and other mechanical parts are designed in accordance with modern locomotive practice

WANTED.

WANTED—to purchase a pontoon or barge having about 30—34-ft. beam and length of 70—80-ft. Long term hire possibly considered. Will inspect where lying. Please reply to Box No. 153, "Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

Manufacturers' Announcements—continued

High Speed Wharf Cranes

The L.S.E. system of auto-dynamic control has been specially developed to meet the increasing demand for a reliable system of hoist motor control for use on high performance cranes where high speed handling of the load is an essential economic requirement. On wharves where the load has to be lifted through a considerable distance, high speed hoisting and lowering, particularly under light hook conditions, may materially reduce a ship's turn-around time and therefore overall operating costs.

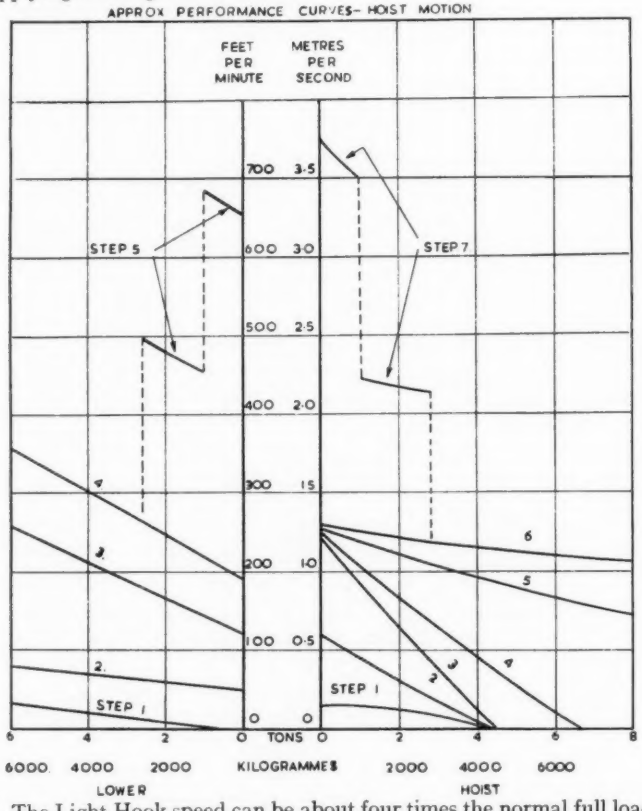
Where a D.C. supply is available, or a group of cranes justifies the installation of a rectifier or a motor-generator set, the auto-dynamic scheme gives the required high performance at a reasonable cost.

A number of important wharf crane installations are in operation on this system and repeat contracts are in hand. In addition, this type of control has been applied very successfully to the latest ship's cargo handling winch, the " Selector." Well over 2,000 winches embodying the auto-dynamic control have been supplied.

This special control system is based on the use of L.S.E. motors in conjunction with L.S.E. contactor control gear, it being essential that the characteristics of motor and control gear be correctly matched to ensure the full efficiency and satisfactory performance of the equipment.

Performance.

The maximum speed of hoisting or lowering is selected automatically to suit the load, so that, even if the operator switches to the high speed step the speed at which a heavy load is hoisted or lowered is restricted to a safe value, while higher speeds are permitted with lighter loads. This is the " Load Weighing " feature which has proved so successful. Intermediate steps provide a choice of slower speeds, so that with very little experience the operator can bring the motor to rest, or to a very slow speed, before switching off and applying the magnetic disc brake.



The Light Hook speed can be about four times the normal full load hoisting speed. With high outputs and high voltages (above 440 volts) this Light Hook speed may have to be reduced slightly, but in all cases a higher speed can be provided than is the case with the usual crane control systems.

When lowering a heavy or medium load, both restraint and braking are obtained by regeneration to the line. In cases where this is not permissible, i.e. only one or two cranes on a rectifier system not capable of accepting returned power, an additional loading resistance can be incorporated in the control gear.

Principles.

The hoist motor is predominantly shunt wound, and speeds above normal are obtained by weakening the shunt field, at medium and light loads, under the control of Load Discriminators. Sub-normal speeds are obtained by suitable combinations of main resistances and armature diversion.

Special patented methods of applying these principles of control permit safe, fast switching of the master controller. This, together with a suitable design of motor with low armature inertia, gives smooth and rapid acceleration and deceleration.

Step 1 Lower provides a slow landing speed by dynamic braking, and a feature of the control is that the motor comes to rest automatically when the load has touched down. The magnetic brake, which is applied only in the "off" position of the master controller, is therefore only used for holding the load under normal operation, and for emergency stopping. This practically eliminates brake wear and the associated maintenance costs.

Special Duty Cranes.

It often occurs that one crane with a wide performance is required for general purposes, or a particular performance for a special duty. In either case the Ward-Leonard system offers many attractive features. The supply can be either A.C. or D.C. and in addition to giving a very wide speed range and a perfectly smooth transition from the highest to the slowest speed, a patented method of obtaining a very slow stable speed at any load can be incorporated.

One interesting application of Ward-Leonard control is the 25 Ton Floating Crane for Mersey Docks and Harbour Board. A further 100 Ton Floating Crane is in hand for the same Authority.

Nylon Driving Belts

The well-known properties of nylon, particularly its great tensile strength, would at first sight appear to qualify it as the ideal material for the construction of power transmission belting. Other characteristics, however—notably nylon's low friction coefficient and its inherent elasticity—present serious technical problems, and the way in which these have been solved in the manufacture of the new Gripoly Nylon Belt is an interesting example of how a long established industry uses ripe experience to adapt new materials to its own purpose.

Messrs. Lewis & Tylor, Limited, are specialists in the manufacture of Solid Woven Belting and have evolved a nylon belt after nearly eight years of experimental work. The new belt consists of a nylon core with an interwoven cotton cover. Since nylon has a tensile strength three to six times as great as that of natural fibres it is possible to make the core considerably less in cross-sectional area than a normal belt, yet with greater strength. The cotton cover, which completely surrounds the nylon core, has a high natural frictional coefficient which is further improved by impregnation with a proofing compound.

Thus cotton provides the belt's grip, and nylon its strength and endurance. Nylon is free from micro-biological attack, and the belt therefore never loses strength from this form of decay—a source of failure much more common with belts of natural fibre than is generally realised. The cotton-nylon construction has a further advantage: by concentrating the stress-bearing material of the belt on the natural axis of bending, great flexibility is achieved, and this is further improved by the type of weave used in the cotton cover.

Nylon is more elastic than cotton, and one of the problems which had to be faced was that there would be a tendency for the core to stretch more than the cover. This was overcome by pre-stressing the nylon and weaving the cotton with a very high weaving angle so that it is, in fact, free from all tensile stress when the belt is in operation. This pre-stressing of the core has proved so successful that, over a wide variety of drives, the stretch is very much less than in any other type of fabric belting.

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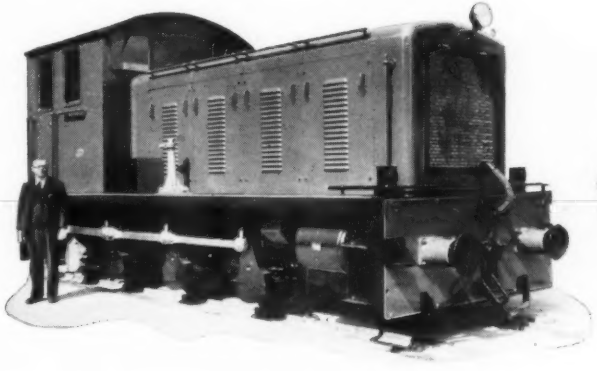

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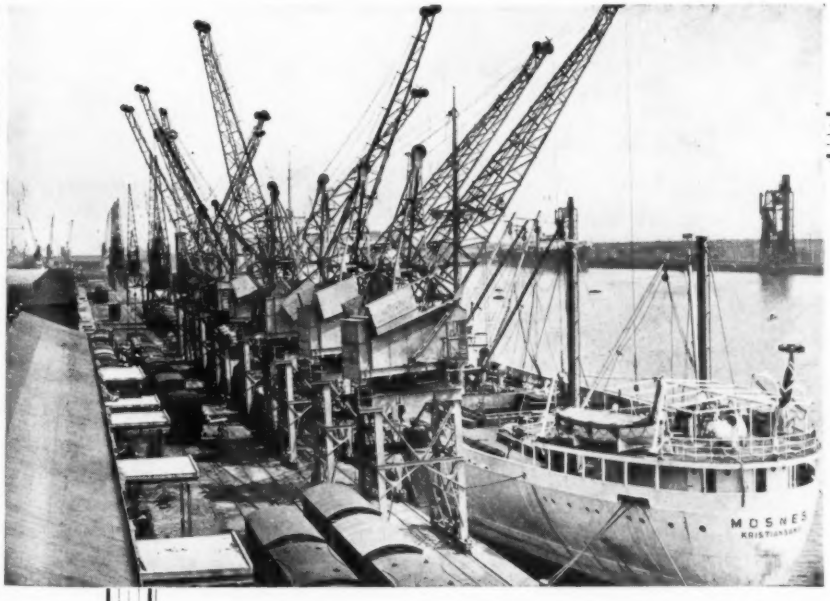

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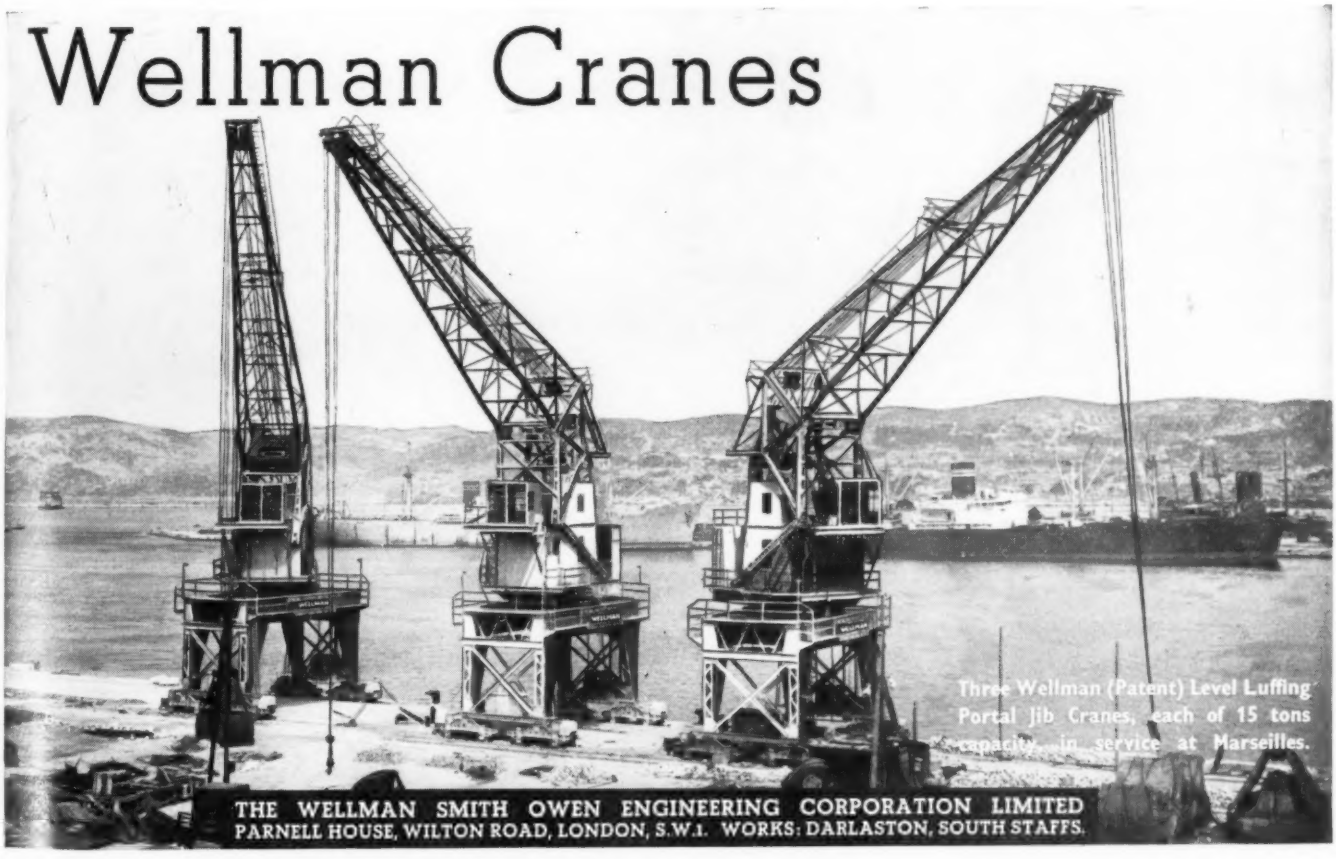

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